May 27, 1957 50 Cents

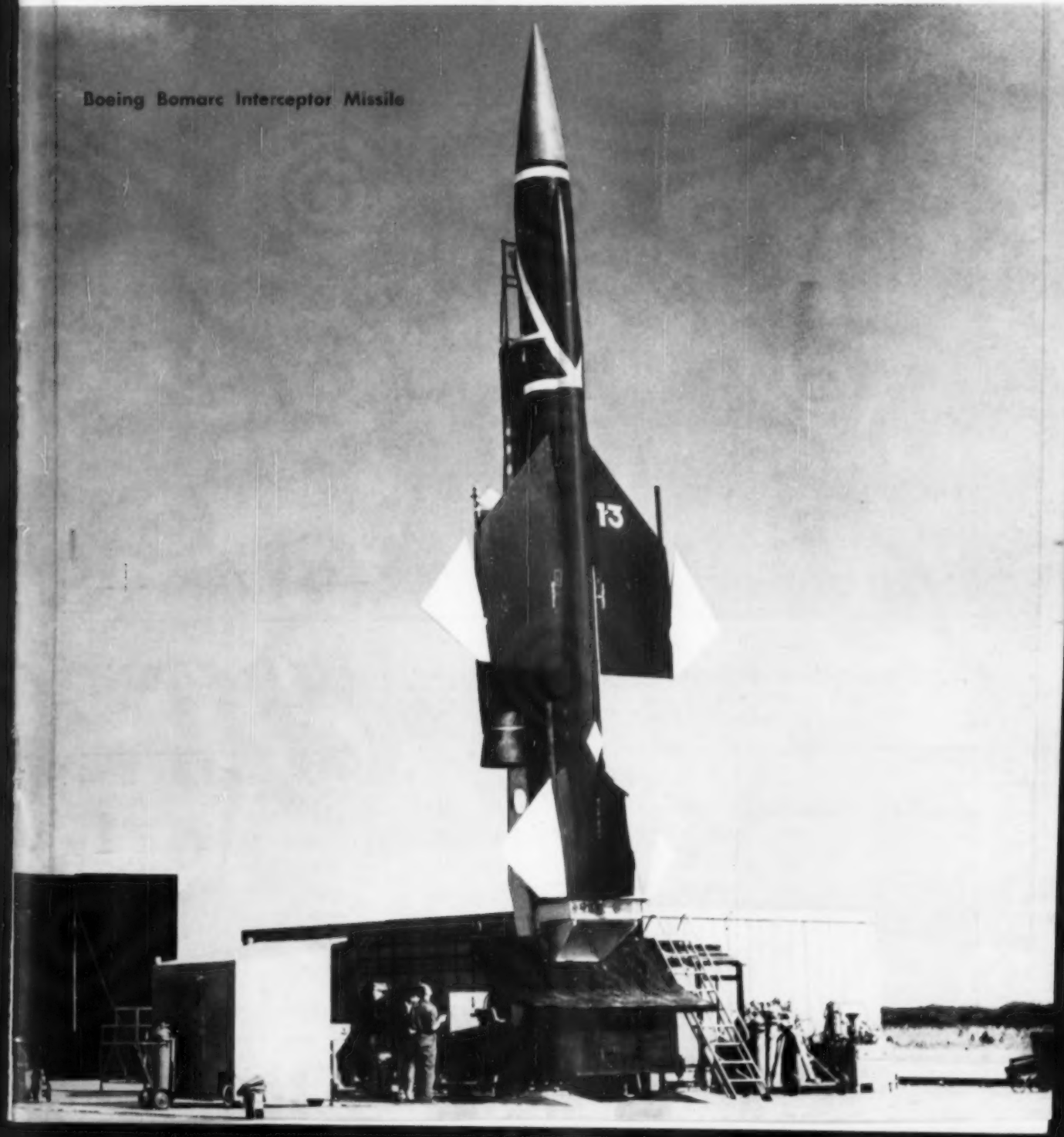
AVIATION WEEK

A McGRAW-HILL PUBLICATION

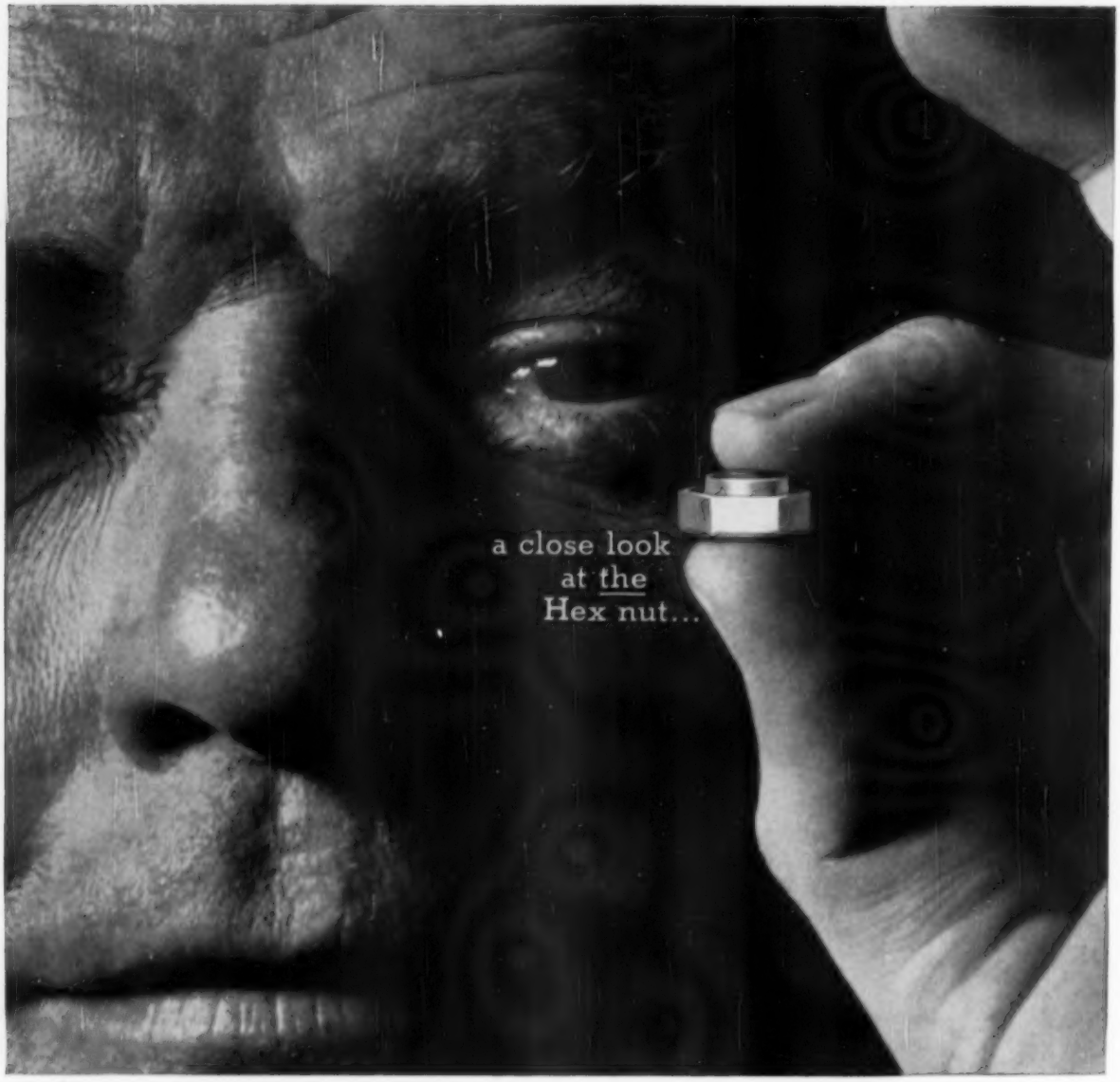
J79 Marked by Low Lead Time

•

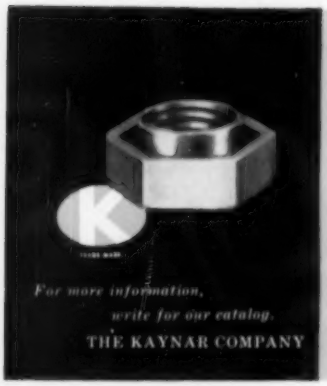
Winged Missile Data Analyzed



Boeing Bomarc Interceptor Missile



...reveals the acknowledged superiority of **KAYLOCK**®
All-metal self-locking nuts



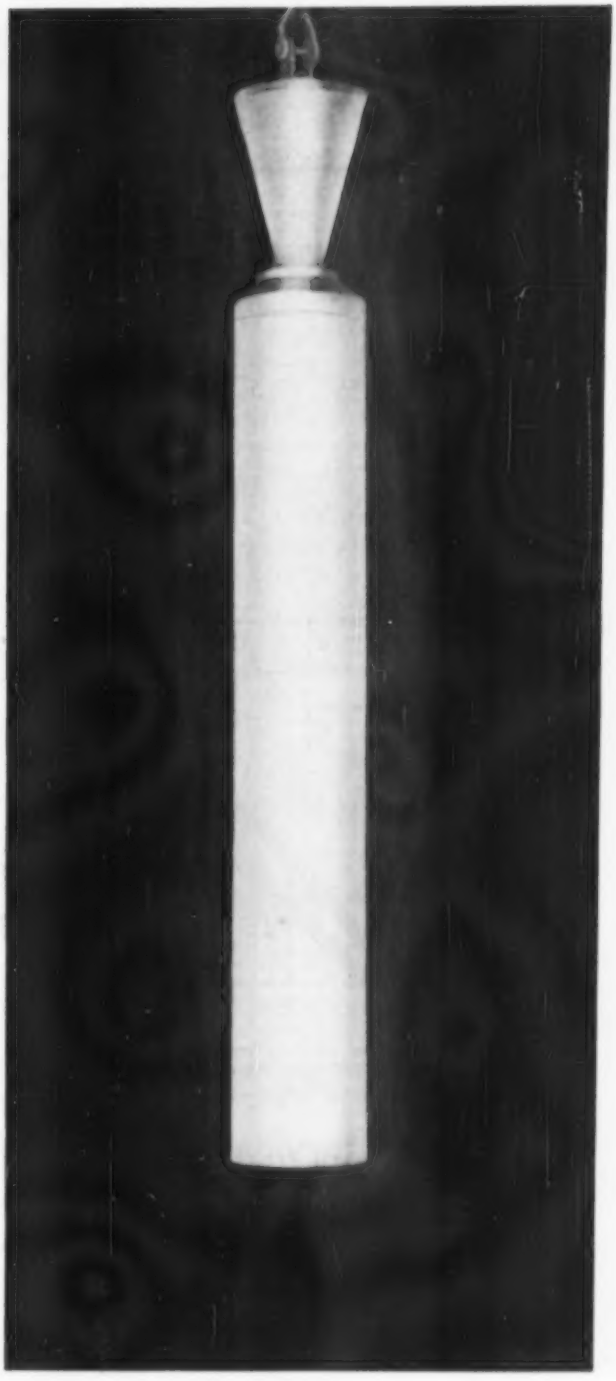
- Lightest weight
- Full strength
- Internal or external wrenching
- Lowest height
- Infinite reuseability
- Most constant locking torque
- Extra high temperature (in corrosion resistant steel)

- This One Kaylock Hex Nut meets the requirements of the New National Aircraft Standards: NAS 679 Low Height Nut, NAS 1021 Regular Height Nut, NAS 1022 Shear Nut; also approved for all three Air Force-Navy Standards: AN363 High Temperature Nut, AN 364 Shear Nut, AN 365 Standard Hex Nut.

KAYLOCK DIVISION, Dept. GH, Box 2001 Terminal Annex • Los Angeles 54, California
Canada Distributor: Abercorn Aero Ltd., Montreal © 1957

SPAWNING GROUND

for a rocket's fury



By the time you read this message, the large rocket motor case shown here—white-hot from heat treating—will be standing ready, loaded with solid propellant, poised to rush a guided missile skyward.

Once it has been triggered into action, this rocket will generate 3500° F. heat—be called upon to withstand pressures of 1200 pounds per square inch—and the thrust from its nozzle will be equal to the power of 50 Diesel locomotives acting in unison.

Spawning such rockets calls for some real engineering—of a type not surpassed anywhere outside of Goodyear Aircraft Corporation.

Two interesting facts bear this out:

(1) Goodyear Aircraft has produced more large-size rocket cases than any other manufacturer—possibly more than all combined.

(2) Goodyear Aircraft maintains one of the largest facilities available in this country for the exacting production. And these facilities are currently completing a huge expansion.

Fact is, Goodyear Aircraft developed the basic design concept which made these large lightweight rockets possible—engineering which slashed the weight of the cases up to 50%.

Summary:

Pioneer skills, vast and varied experience, complete facilities and ready availability make Goodyear Aircraft the surest thing in rockets. Write: Goodyear Aircraft Corporation, Dept. 931AE, Akron 15, Ohio.

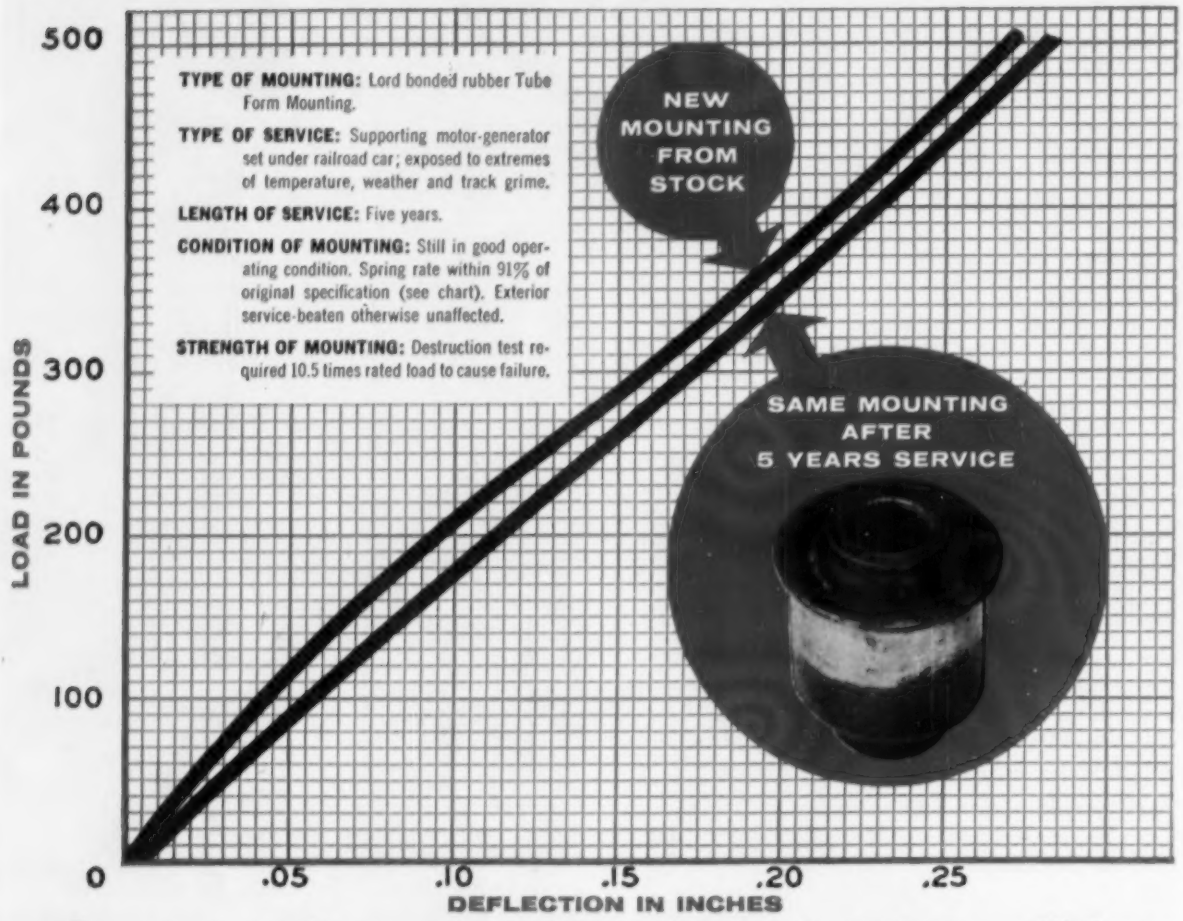
They're doing big things at

GOODYEAR AIRCRAFT

Plants in Akron, Ohio, and Litchfield Park, Arizona

Rewarding Careers for Engineers

what is the life expectancy of a LORD vibration mounting?


500
400
300
200
100
0
LOAD IN POUNDS
.05
.10
.15
.20
.25
DEFLECTION IN INCHES
TYPE OF MOUNTING: Lord bonded rubber Tube Form Mounting.
TYPE OF SERVICE: Supporting motor-generator set under railroad car; exposed to extremes of temperature, weather and track grime.
LENGTH OF SERVICE: Five years.
CONDITION OF MOUNTING: Still in good operating condition. Spring rate within 91% of original specification (see chart). Exterior service-beaten otherwise unaffected.
STRENGTH OF MOUNTING: Destruction test required 10.5 times rated load to cause failure.
NEW MOUNTING FROM STOCK
SAME MOUNTING AFTER 5 YEARS SERVICE

► *five-year service results in little change in isolation efficiency*

How long do LORD bonded rubber mountings retain their excellent vibration isolation characteristics?

Recently, LORD had an opportunity to test a mounting which had been exposed to five years of rigorous service. The remarkable results shown above are a convincing demonstration of the extra-long life of LORD mountings.

This was not an exceptional case, but is typical of the continuous, long-term effectiveness of all LORD products. It is the planned result of (1) the careful design of the contour of the flexing element to provide uniform stress distribution, (2) a rubber-to-metal bond of unsurpassed strength and permanence and (3) elastomers which are specially selected and custom-compounded for each job. And LORD engineers are constantly striving to build even more life into LORD mountings.

The like-new performance of LORD mountings even after long, rugged service means much in terms of lower lifetime costs, fewer mounting replacements, and greater safety.

When you have a problem in vibration control, it makes sense to bring it to LORD—the leader in engineering vibration control and bonded rubber products. Contact your nearest LORD Field engineer or the Home Office, Erie, Pa.

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BONDED RUBBER

designers and producers of bonded rubber products since 1924

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AVIATION CALENDAR

May 28-29—Annual Business Aircraft Safety Seminar, sponsored by Flight Safety Foundation, Park Sheraton Hotel, New York.

May 30-June 2—Wright Memorial Glider Meet, sponsored by Soaring Society of Dayton, Cox Municipal Airport, Dayton.

June 1—8th Annual Maintenance and Operations Meeting for Business and Executive Aircraft Owners, sponsored by Reading Aviation Service, Reading Municipal Airport, Pa.

June 3-5—First General Aviation Law-Science Seminar, Wichita University, Kans.

June 4-5—1957 Biennial Electronic Materials Symposium, University of Pennsylvania, Philadelphia, sponsored by Institute of Radio Engineers and University of Pennsylvania.

June 6-7—National Symposium on (Electronic) Production Techniques, Willard Hotel, Washington, D. C.

June 8-12—Technical Personnel Recruiting Exposition, in conjunction with National Technical Career Conference, Sherman Hotel, Chicago, Ill.

June 9-14—Semi-Annual Meeting, American Society of Mechanical Engineers, Sheraton Palace Hotel, San Francisco.

June 10-14—Lecture Series on Vacuum Metallurgy, sponsored by New York University College of Engineering. Address inquiries to Dr. R. F. Bunshah, New York University College of Engineering, University Heights 53, N. Y.

June 7-8—30th Annual Homecoming & Reunion, Parks College, East St. Louis, Ill.

June 11-13—3rd Western Plant Maintenance & Engineering Conference, Civic Auditorium, San Francisco, Calif.

June 14—Plastics for Electronics, New England Section, Society of Plastics Engineers, Lowell Technological Institute, Lowell, Mass.

June 17-19—National Convention on Military Electronics, Sheraton-Park Hotel, Washington, D. C., sponsored by Institute of Radio Engineers.

(Continued on page 6)

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Vol. 66, No. 21

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Cast in stainless steel, this nozzle ring for a rocket engine represents the ultimate in intricate casting design. The absolute accuracy of core placement, its close tolerances, its thin metal sections, its internal quality—these exacting requirements foreshadow the foundry techniques of tomorrow, now being employed at Lebanon *today*.

THIS CAST NOZZLE RING FOR REACTION MOTORS will help power a rocket into outer space. With the successful production of this casting, Lebanon Steel Foundry stands at the very frontier of its industry.

What significance does this have for you? Simply this . . .

If your project utilizes cast steel in any form, you will gain by contacting Lebanon Steel Foundry during its initial design phase. Our superior knowledge and experience is available to you at the time when they can most effectively produce quality improvements and cost savings.

The most difficult casting requirements—close tolerances, smooth surfaces, dimensional accuracy, intricate metal sections and internal integrity—are being met daily at Lebanon, and this vast fund of foundry know-how is available to you.

Send us your blueprints. Our foundry engineers welcome the opportunity to share their experience with you.

CIRCLE L

Write for Lebanon's Design File "F"

LEBANON STEEL FOUNDRY

65 LEHMAN STREET LEBANON, PENNSYLVANIA

CARBON, LOW ALLOY AND STAINLESS STEEL CASTINGS

Another famous plane

PROVEN IN SERVICE

1935

History is made on November 22 when Pan American's "China Clipper" flew the first trans-Pacific air mail, from San Francisco to Hawaii and Manila.

Today the first trans-Pacific air mail flight is but another fond memory of the "good old days of aviation." But even in 1935, twenty-two years ago, Rockbestos wire and cable had earned a proven-in-service reputation.

Today, Rockbestos can look back on 39 years of developing and manufacturing quality wire and cable, and a long history of close association with the aviation industry.

Rockbestos has continually produced high temperature wire which meets the exacting standards of modern airplanes . . . both military and commercial.

Rockbestos will continue to develop wires to meet the aircraft industry's needs. Find out just how Rockbestos can help solve your high temperature wiring problems. Write, wire or phone for complete specifications and application information.

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AVIATION CALENDAR

(Continued from page 5)

June 17-20—Eighth All Women's International Air Race, McAllen, Tex.-Cuba. For details, write: Miss Irma Price, Entry Chief, 242 W. 8th St., Miami, Fla.

June 17-20—National Summer Meeting, Institute of the Aeronautical Sciences, Biltmore Hotel, Los Angeles, Calif.

June 22-23—Golden Anniversary of the Air Force, New England observance, L. G. Hanscom Field, Bedford, Mass.

June 23-25—29th Annual Meeting, Aviation Distributors & Manufacturers Assn., The Broadmoor, Colorado Springs, Colo.

June 24—Soviet National Aviation Day, Moscow.

June 24-28—American Institute of Electrical Engineers, summer general meeting, Sheraton Mt. Royal Hotel, Montreal, Canada.

June 27-29—13th Annual Meeting, Institute of Navigation, Sheraton-Park Hotel, Washington, D. C.

July 2-11—24th National Soaring Contest, Harris Hill, Elmira, N. Y.

July 6-10—Eleventh All-Women Transcontinental Air Race, from San Mateo County Airport, Carlos, Calif., to North Philadelphia Airport, Pa.

July 12-13—British Lockheed International Aerobatic Competition, the National Air Races (third round) and the King's Cup Air Race, Coventry Civil Aerodrome, Baginton, England.

July 28—Third Annual Jaycee Air Fair, sponsored by Aviation Committee, Portland (Oregon) and Junior Chamber of Commerce, Portland International Airport.

July 31-Aug. 4—Eleventh Annual National Convention, Air Force Assn., and Airpower Panorama, Sheraton-Park and Shoreham Hotels, Washington, D. C.

Aug. 6-10—National Aviation Meeting Institute of Aeronautical Sciences, U.S. Grant Hotel, San Diego, Calif.

Aug. 10-11—Midget Airplane Races, Oshkosh, Wisc.

Aug. 20-22—Bendix-Scintilla International Ignition Conference annual meeting, Sidney, N. Y.

Aug. 20-23—Western Electronic Show & Convention, Cow Palace, San Francisco.

Aug. 26-28—Gas Dynamics Symposium, Transport Properties in Gases at High Temperatures and Pressures, Technological Institute, Northwestern University, Evanston, Ill.

Aug. 31-Sept. 1—Midget Airplane Races, Ft. Wayne, Ind.

Sept. 1-15—Sixth International Aeronautical Conference, Royal Aeronautical Society and Institute of the Aeronautical Sciences, Folkstone and London, England.

Sept. 2-8—1957 Flying Display, Society of British Aircraft Constructors, Farnborough, England.

Sept. 3-14—XIth General Assembly, International Union of Geodesy and Geophysics, in conjunction with International Geophysical Year, University of Toronto, Canada.

Sept. 13—Third Pacific Area National Meeting, American Society for Testing Materials, Sheraton Palace Hotel, San Francisco, Calif.

"FOLLOW THROUGH"

During more than ten years of pioneering the use of structural adhesives and laminating materials, Narmco has found that the airframe and missile manufacturer requires much more than the simple delivery of materials to his receiving department. He expects more... and rightly so! In today's complex business of producing supersonic aircraft and missiles, close supplier-user cooperation is essential. That's why Narmco has developed, and continues to emphasize as a policy, the use of "control" records for every customer... no matter how large or small.

Although Narmco inspects and tests products 100%... with over 27 separate checkpoints established in the production lines for performing precise, in-process and final control tests... Narmco goes even farther in its efforts to provide the ultimate in "down to earth" quality assurance to its customers. Generous physical samples of all Narmco production... structural adhesives... laminating materials... coating solutions and coated materials... and putties and resins are randomly selected during production and retained a minimum of 90 days after every shipment.

This makes it possible to provide the customer sample characteristics data on the specific material he received. This procedure affords the manufacturer an important "follow through" service in analyzing his own handling, storage, and use of the product and has frequently resulted in direct savings in manhours and materials when solving "stubborn" production control problems.

This unusual customer service "plus" is another important element in Narmco's assistance to the manufacturer... another reason why more and more Narmco products are being used in the airframe and missile industry... *doing jobs every day that metals alone can't do!*

NARMCO

PIONEERING THROUGH RESEARCH

Narmco technical field representatives throughout the United States and Canada can assist in solving your structural design problems quickly, efficiently and economically. For immediate assistance, write, wire or phone...

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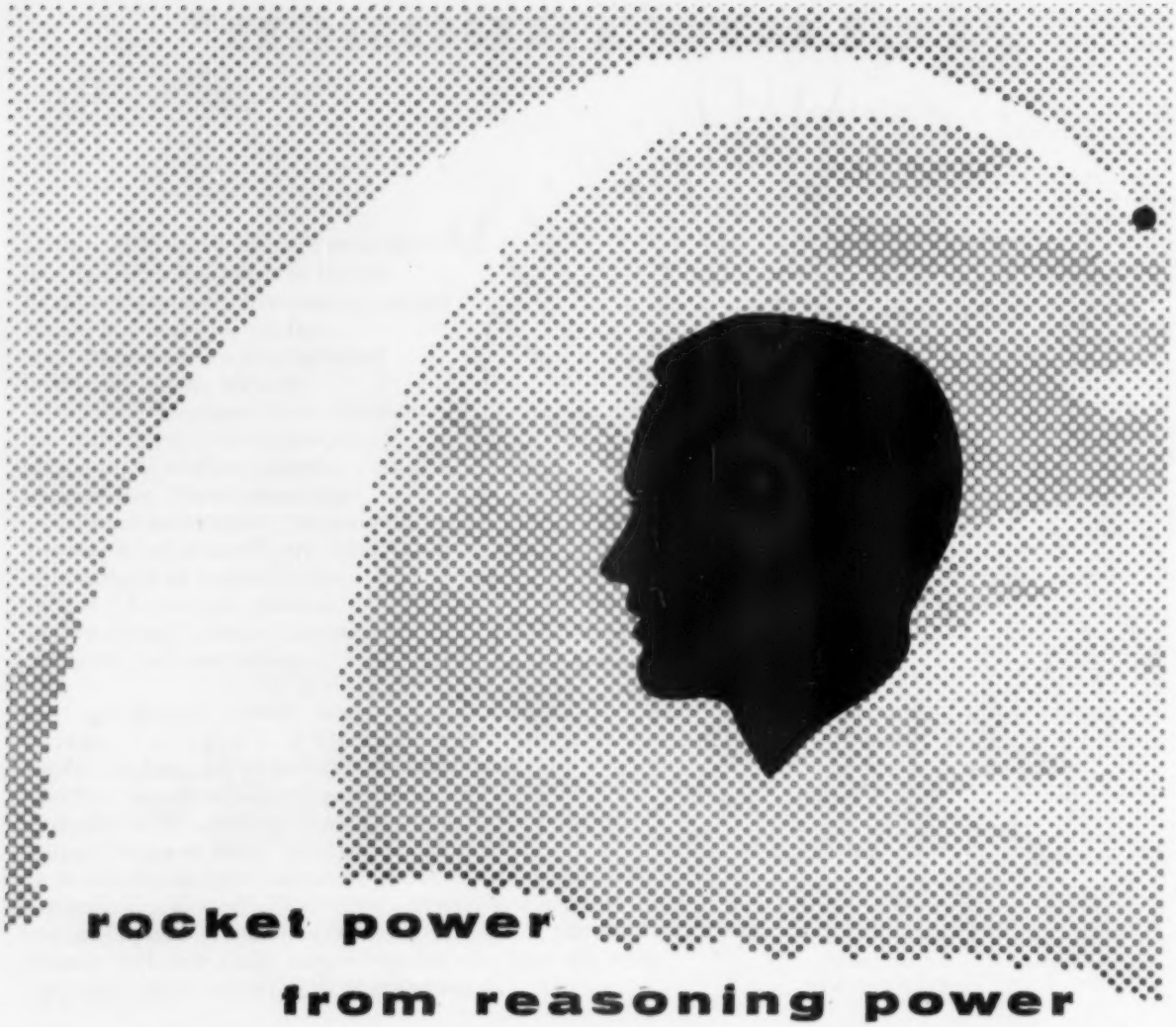

rocket power from reasoning power

A *reasoning* mind—man has always found this his most useful weapon when venturing into unknown fields. Today's frontier—one of the greatest unknowns ever faced by man—lies in outer space.

RMI, America's *first* rocket family, is uniquely qualified to help our country conquer the new frontier. For this project will require more powerful and more efficient rocket propulsion systems than any yet designed. And RMI's experience in the rocket power field extends back over 15 years . . . years in which RMI scientists and engineers pooled their reasoning power and knowledge to develop entirely new methods of propulsion and to produce rocket powerplants for dozens of military vehicles.

With this backlog of experience—and with an increasing staff of imaginative, reasoning engineers—RMI continues to blaze trails in many fields of rocket power: supersonic manned aircraft . . . versatile helicopters . . . catapults and test sleds . . . and missiles for defense and space exploration.

Engineers, Scientists—Perhaps you, too, can work with America's *first* rocket family. You'll find the problems challenging, the rewards great.

Power for Progress

RMI

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PRECISION TITANIUM FORGINGS

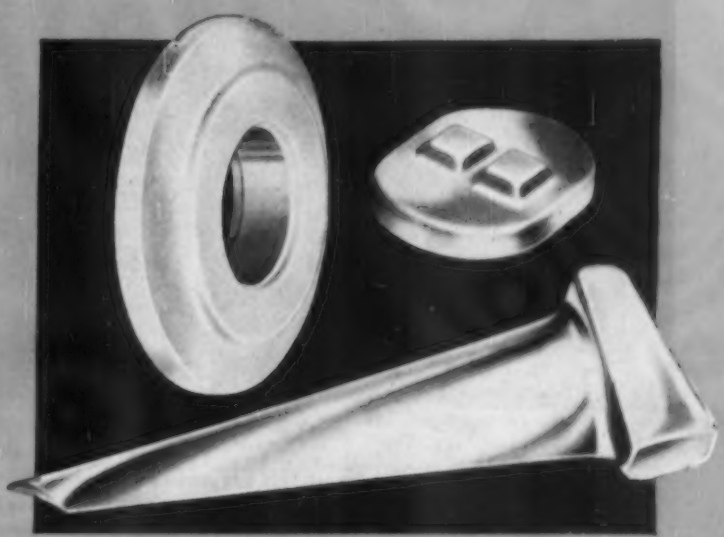
from Canada-at much lower cost

An entirely new forging process for Titanium has been developed by CSI, Canada's foremost forging and casting company, specialists in blades, buckets and forged components for jet engines. The new process enables CSI to produce Titanium parts of the *highest standards at the lowest prices in the world.*

Here are some of the characteristics of Titanium forged by this new process:

- Precision tolerances.
- Complete freedom from surface embrittlement due to gaseous contamination.
- Excellent surface finish.
- Greatly reduced machining costs—for example jet blade airfoils require polishing only.
- Consistent quality maintained.

Besides taking the lead in Titanium, CSI are also highly skilled and experienced in the production of high temperature alloy forgings and in forgings or castings of aluminum and magnesium.



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The manufacturers of jet aircraft engines, (and American Welding supplies every major jet engine manufacturer), have learned that there is an inherent savings of material and machining time in the use of flash-welded rings and components fabricated from mill-rolled and extruded shapes.

Might there be a lesson here for the manufacturers of missiles? We think that a missile could go a long way using Amweld's facilities and know-how.

Why not contact our Industrial Products Division today for more information about how Amweld may serve you.

THE AMERICAN WELDING & MANUFACTURING CO.
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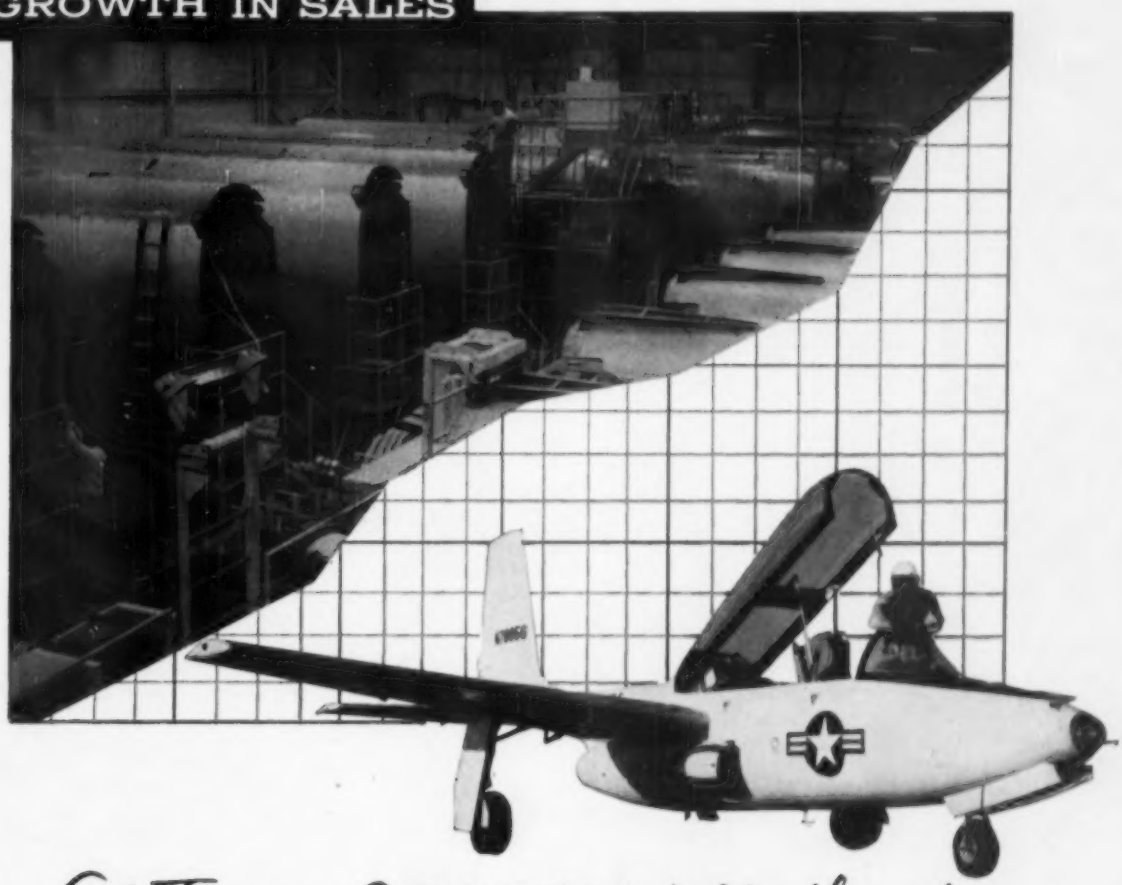
AMERICAN WELDING
The World's Leading Manufacturer of Welded Rings

IN ENGINEERING THE BEST OPPORTUNITIES ARE IN AVIATION • IN AVIATION THE BEST OPPORTUNITIES ARE AT TEMCO

GROWTH IN SALES



At Temco GROWTH tells the story

Growth — in total sales, for example — tells the Temco success story.

During Temco's past decade of planned progress, sales have steadily increased from $5½ million in 1946 to a new high of over $90 million in 1956! At year's end, business backlog had almost doubled during 1956 to represent a net new business volume of $174 million for the year.

And the future looks even brighter . . . thanks to Temco's greatly expanded activities in research and development of jet aircraft, missiles and weapons systems.

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Mr. Joe Russell, Engineering Personnel
Room 103-I, Temco Aircraft Corp., Dallas, Texas

Please send me complete details of the Temco story of unusual opportunities for experienced engineers.

I am especially interested in_____

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USED BY AIR FORCES OF TWENTY-EIGHT NATIONS

The Patented Mark 4 Fully Automatic Lightweight Ejection Seat is designed and produced by the Martin-Baker Aircraft Company Limited.

Considerable ingenuity in design has resulted in a seat of remarkably low installed weight and compact construction. Tests have proved that the seat is capable of effecting safe escape at all speeds and altitudes within the range of modern aircraft.

Safe escape from ground level is practicable because of the high velocity of the long stroke Ejection Gun and the rapid deployment of the main parachute. At very high ejection speeds the opening of the main parachute is delayed by a patented automatic sensing mechanism which is sensitive to the rate of deceleration of the seat. The well proven time fired drogue gun, Duplex Drogue system and barostatic time release mechanism which have been so successful in earlier seats have been retained, though considerably lightened and improved in detail design.

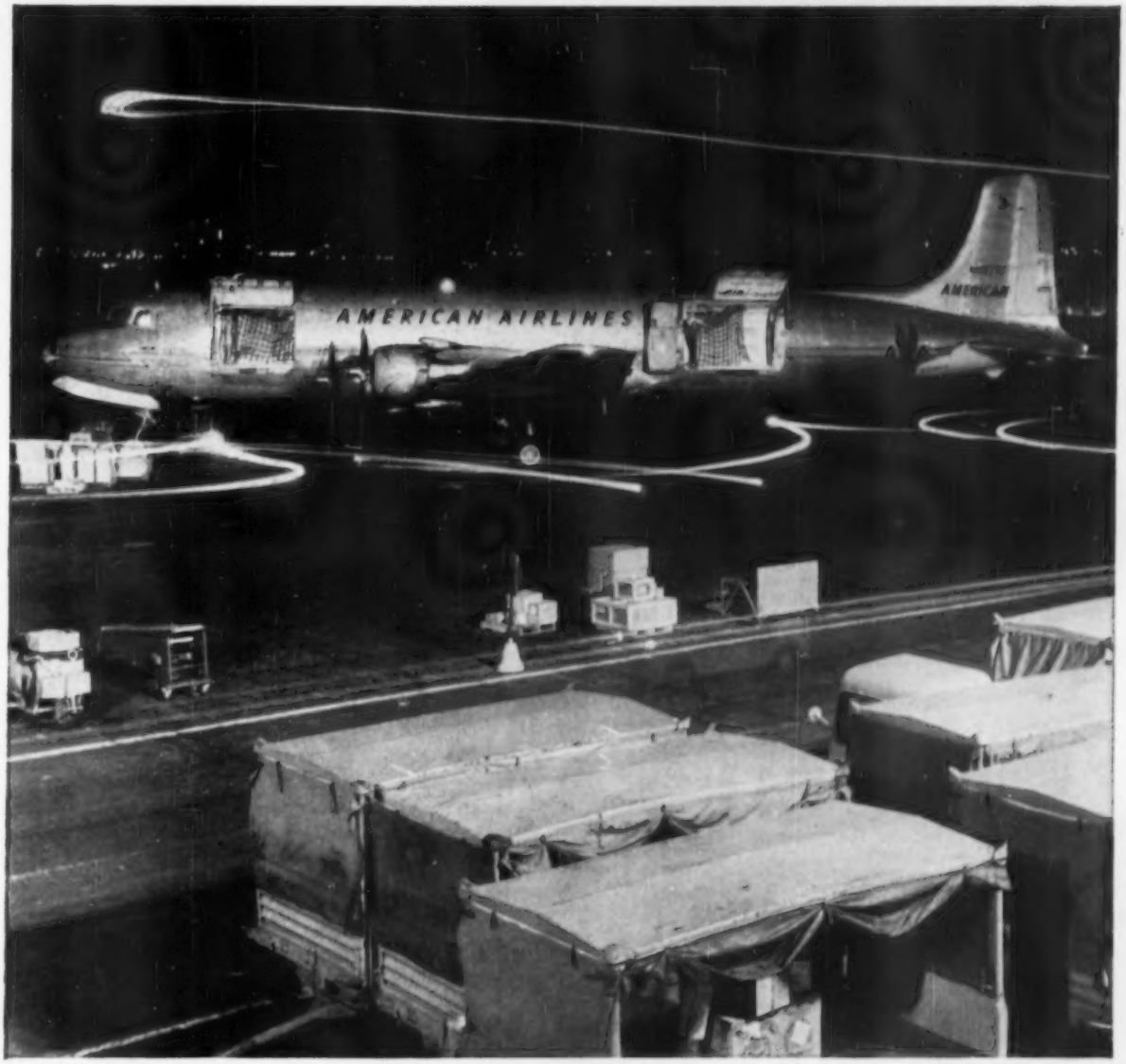
Production of the seat has been preceded by extensive design and test programmes, ejections being carried out at all speeds and at altitudes ranging from ground level to more than 42,000 feet.

Martin-Baker

AIRCRAFT COMPANY LIMITED

ENGLAND & CANADA

DEPENDABILITY



with the greatest dependability in airfreight, American serves aviation executives better than any other airline!

Specify American Airlines Airfreight—the carrier that offers the best assurance of expert handling and on-time deliveries. American offers this greater dependability because American leads all other airlines in experience, capacity, coverage of key cities and frequency of schedules.

AMERICAN AIRLINES AIRFREIGHT

—flies more freight than any other airline in the world

Based on proven Simulator experience

SWISSAIR

SWISSAIR SELECTS the DC-8 JET SIMULATOR by Curtiss-Wright

SWISSAIR, the airline of Switzerland that "combines the proverbial precision of the Swiss watch with the traditional hospitality of the Swiss hotels," has selected the Douglas DC-8 Electronic Simulator built by Curtiss-Wright for training its future jet crews.

SWISSAIR, veteran in Simulator training, selected the DC-8 equipment by Curtiss-Wright on the basis of its proven experience with Simulators for reciprocating engine aircraft types, also built by Curtiss-Wright.

Pioneer of flight simulation in 1948, Curtiss-Wright has a total of 27 types of Simulators in service or in production. This unparalleled experience in Simulators for every type of aircraft is reflected in the superior fidelity, performance and dependability of Jet Simulators built by Curtiss-Wright. The cost reductions and increased crew efficiencies resulting from the use of Simulators built by Curtiss-Wright are *documented fact*.

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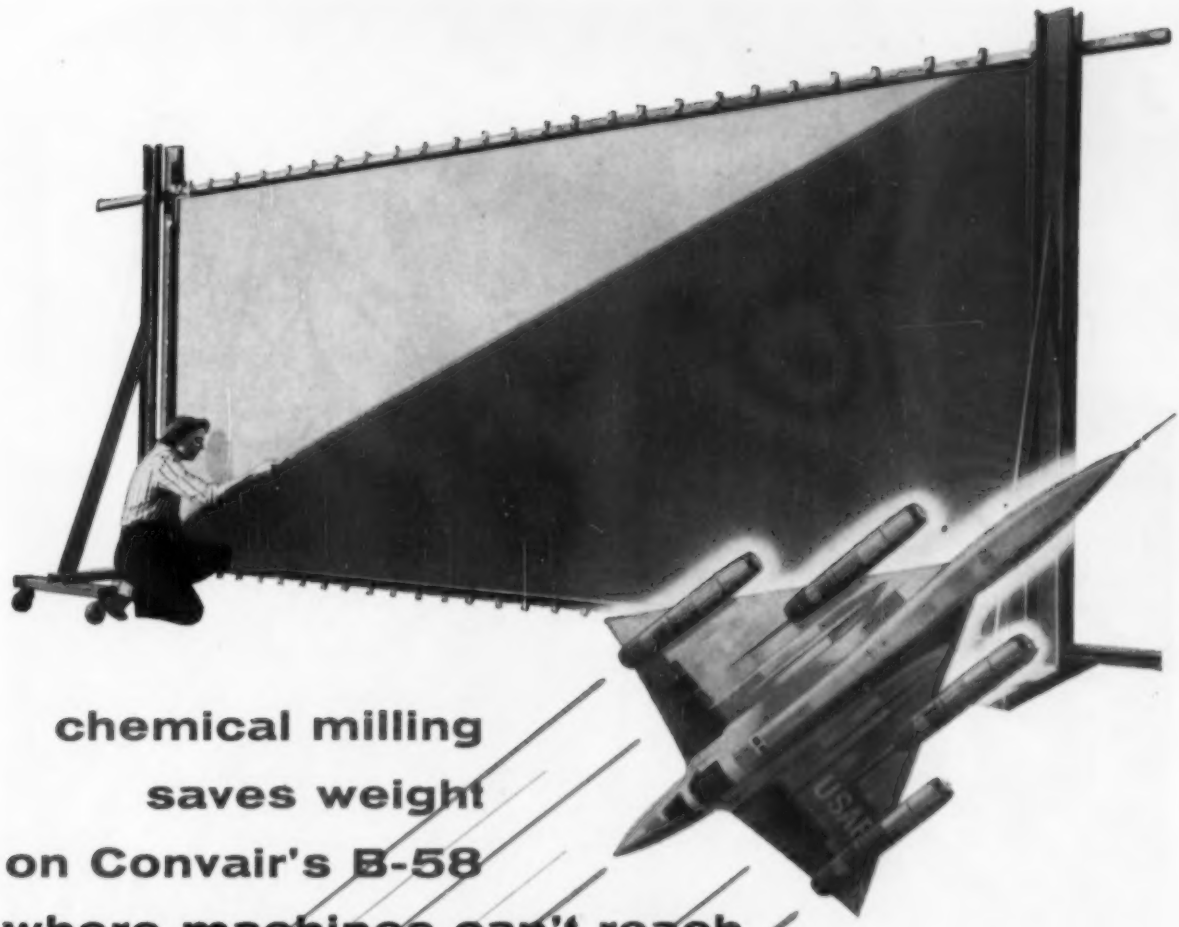

chemical milling saves weight on Convair's B-58 where machines can't reach

The wing and stabilizer skins

of America's first supersonic bomber, Convair's mighty B-58, are chemically milled by USCM. ***Chemical milling removes more than 600 pounds that could not be removed economically by any other method.***

Over 100 different part numbers in aluminum sheet range up to 84" wide by 258" long, in gauges from .064" to .125". USCM reduces these gauges in varying amounts down to finished thicknesses as low as .015", much thinner than could be accomplished except by chemical milling.

Producibility is excellent

Tanks now in round-the-clock production at USCM are 50' long, 12' deep and 6' wide. Any number of parts can be run at one time, up to tank capacity. A complete engineering, tooling and laboratory research staff is ready to help you apply chemical milling manufacturing methods to your design problems.

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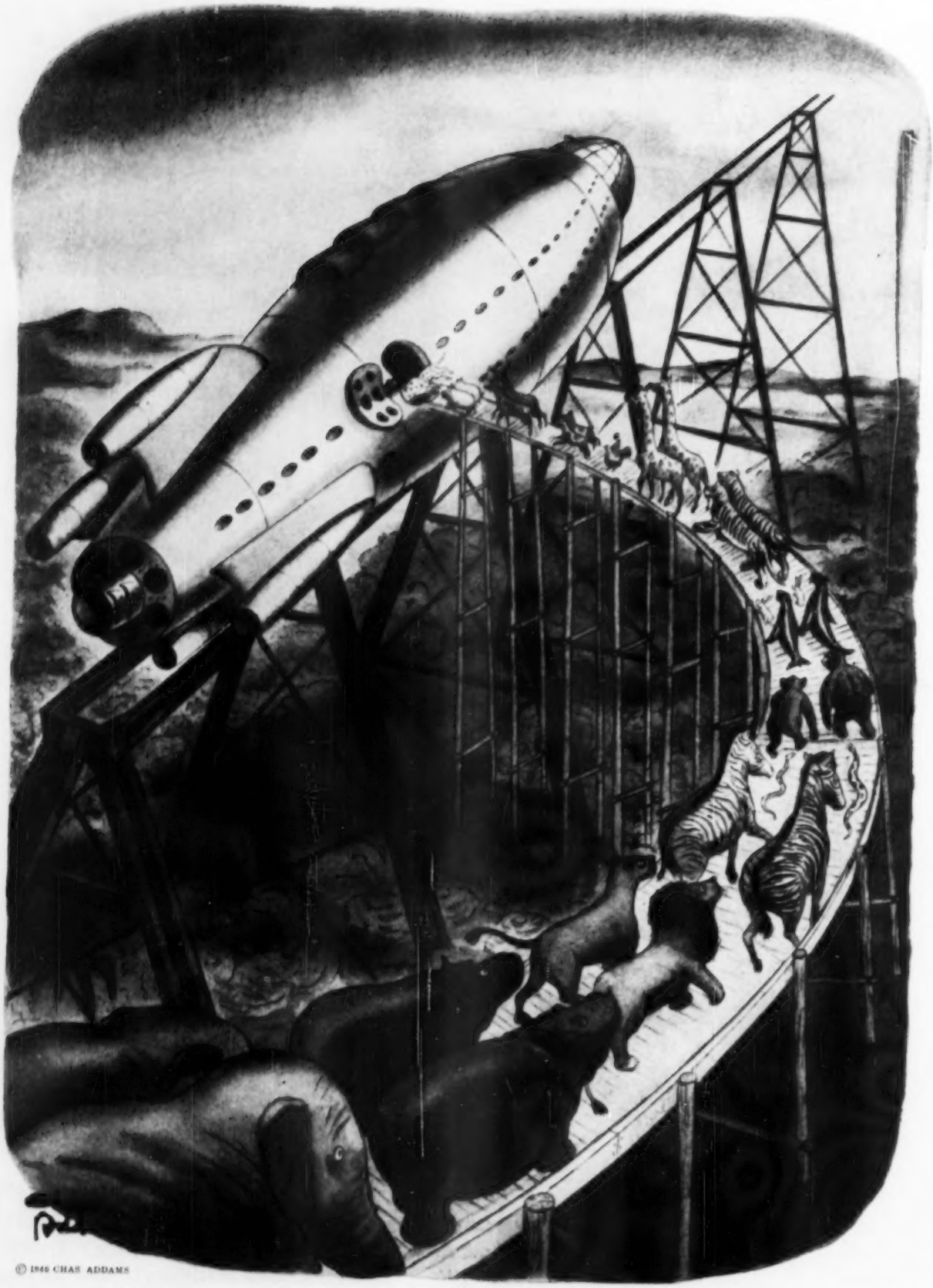

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Our Special Products Division designs and builds launching stands, test towers, ground-movement vehicles, and storage devices for *almost* any size missile, anywhere.

What do we know about ground-support devices for missiles?

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Our ideas on ground-support vehicles and structures for missiles are firmly based on 33 years of experience.

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Your missile project ...and creative engineering

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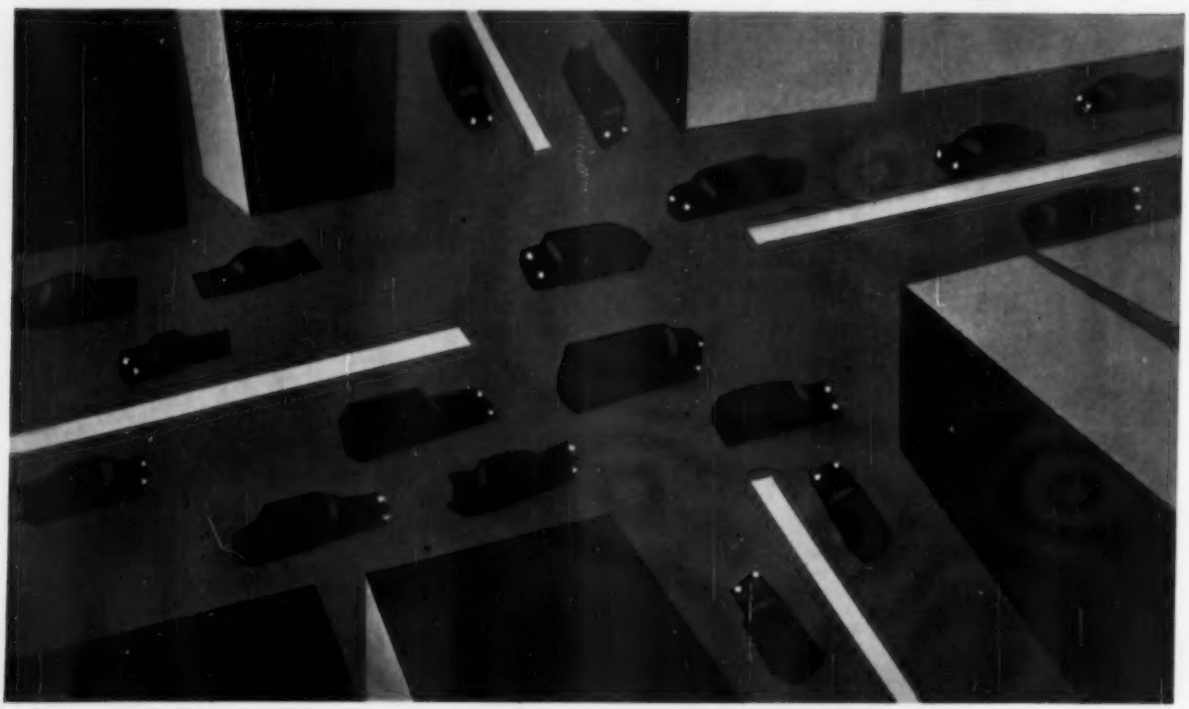

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EDITORIAL

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COVER: First photographs of the Boeing Bomarc IM-99 interceptor missile reveal the ramjet powered vehicle has all movable wing and tail surface tips for control. Liquid propellant rocket motor boosts Bomarc off vertical launcher and accelerates it to speeds high enough for two Marquardt ramjets to take over as powerplants. Other pictures on pages 38-39.

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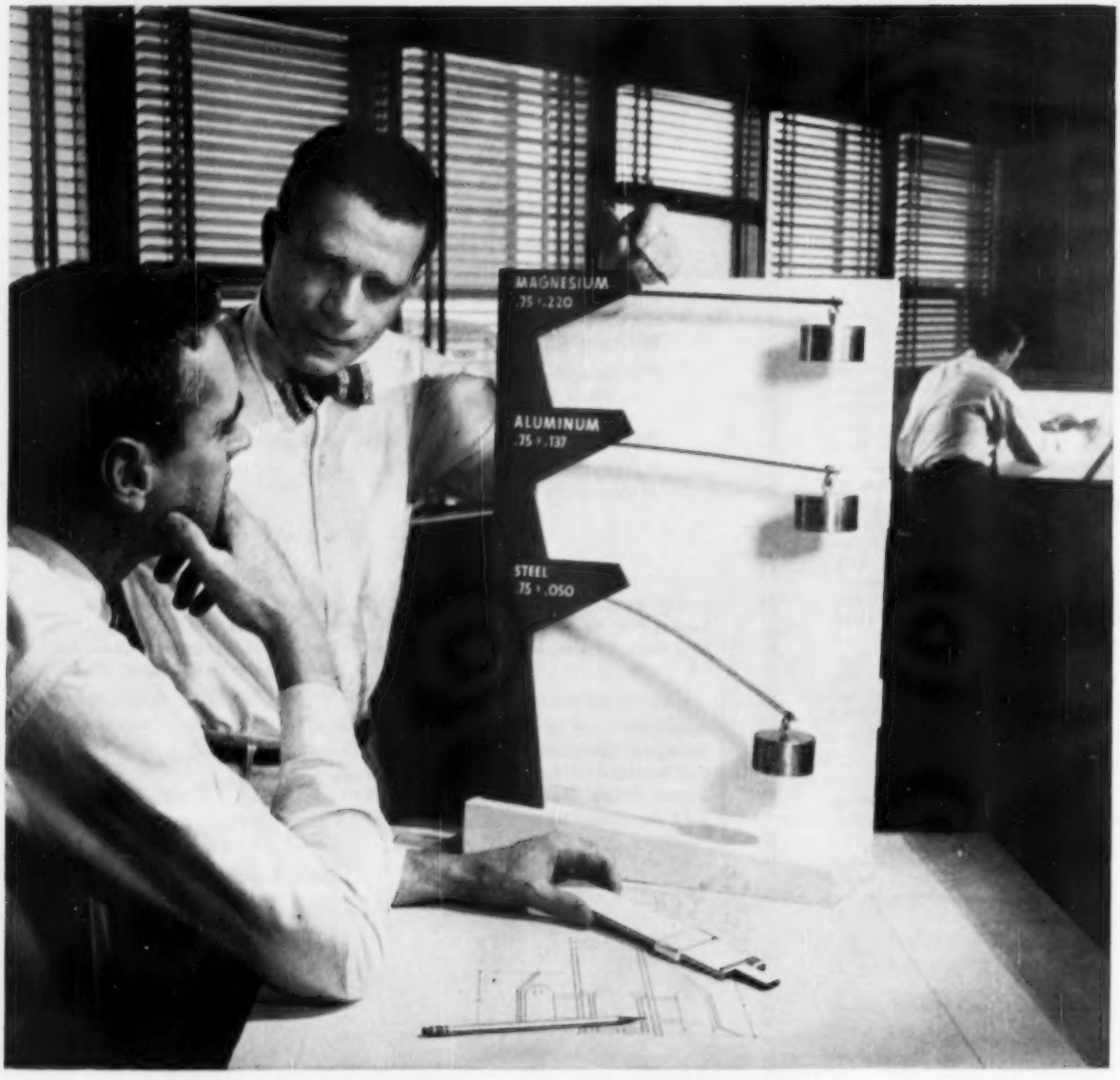

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EDITORIAL

Are We Wasting Precious Airspace?

One of the most sensitive areas covered by the final report of Edward P. Curtis, special aviation facilities planning adviser to President Eisenhower, deals with the use of airspace. Knowledgeable people who have been wrestling with the air traffic control problem during the past decade have been aware that there is a major problem in allocating airspace for military and civil use.

The airspace over this country is a precious natural resource that cannot be squandered by any special interest group the way the timber barons once stripped our forests or the way that some industries and communities now pollute our waters. As the Curtis report aptly emphasizes:

"What we have overlooked was the possibility that this seemingly limitless ocean of air might be quickly overcrowded."

Unilateral Military Claims

This overcrowding of airspace is now apparent to all. But what is not so apparent is the extent to which this overcrowding is caused, not just by increased numbers of operational aircraft but also by the greedy, unilateral gobbling of vast airspaces by military agencies. As things now stand, there is no effective effort directed toward developing a common co-ordinated use of our airspace resources to meet adequately the needs of both military and civil users.

Part of the airspace problem is technical, caused by the advent of large scale military jet operations that require more air in which to operate safely. This phase will grow more acute as the airlines shift into large scale jet operations. But even more serious is the attitude of the military aviation agencies in unilaterally staking out their claims to large airspaces in key areas without any regard for the civil users of airspace.

Aviation Week has watched this military appetite for airspace grow enormously during the past decade and from time to time we have spoken out against the arrogance and disregard for the overall public good that has been exhibited by key military personnel handling these matters. In this issue on page 40 Aviation Week's Transport Editor L. L. Doty details how military opposition at this late date is blocking establishment of effective air traffic control in the Grand Canyon area where a tragic mid-air collision claimed 127 lives last June.

Changing Needs

A few weeks ago, we also detailed how the military RAPCOM has created an artificial air traffic bottleneck in the Detroit area by considering only the military phase of the problem involved.

There is no question but that the Air Force, naval aviation and the fast-growing aviation effort of the Army face new and serious problems in operating effective military airpower. Since the end of World War II, military aviation operations have changed their basic character in the airspace of the U.S. They have shifted from primarily training operations to actual combat operations as both Strategic Air Command and Air Defense Command have been forced by the nature of their changing problem to operate from combat bases on the North American continent.

No one would deny the military the airspace it really needs to do its job effectively. But what has been so irritating to other users of the airspace has been the military attitude that it has top priority on all of the airspace it fancies; that civil airspace users have few if any legitimate claims to critical airspace, and that the military can unilaterally usurp all of the airspace it wants.

The files of civil airways users are thick with case histories of specific military appropriation of airspace done more in the manner of dictatorial bureaucracy than the democratic processes of our form of government. This is the type of problem that the Airspace Panel of the Air Co-ordinating Committee has been unable to handle effectively.

Mushrooming Military Airspace

The Curtis report points out that reserved airspace for military use has now reached a total of 370,000 square miles—an increase of 228% in the last seven years.

"We realize now," the report states, "because of the manner in which this airspace has been allocated that in large sectors of the country a congested condition exists forcing serious inflexibility upon both the civil airways and military training operations.

"Thus far, airspace has been granted in a case-by-case basis. . . . No government official with a common interest in civil and military aviation has effectively questioned the need for new restricted areas requested by the military or the patchwork growth of zig-zag airways between cities around such areas. Likewise, no one monitors the actual use of restricted airspace to confirm the military."

The Curtis report has courageously put the finger on an extremely sore and sensitive point that is blocking air traffic control progress. It is a problem about which something can be done now without requiring any new electronic devices or anything more complicated than an intelligent human brain.

The Curtis report recommends action on this problem as follows:

"That the development of long range air space plans, national airspace policy and the assignment of all U.S. airspace be made the responsibility of the federal aviation agency."

We heartily agree!!

—Robert Hotz

Boeing 707 Intercontinental—drawing courtesy Boeing Airplane Co.

CHR's high tear strength silicone rubber picked for 707's major door and window seals

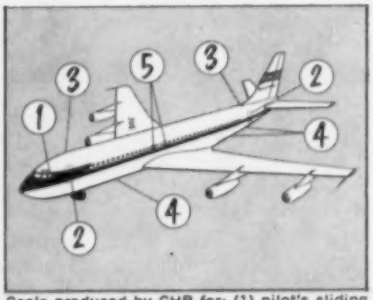
These seals, produced by CHR, will resist tear, abrasion, compression set, weathering, sticking, —100°F. to 400°F.

All present versions of the Boeing 707 will have silicone rubber door, window and hatch seals in the important traffic areas. The speeds, altitudes and temperatures to be encountered by the 707s would soon render organic rubber seals useless in working areas such as the pilot's sliding window, the passenger, cargo and galley doors where silicone rubber is to be used.

It is significant that the seals for these areas will be produced by CHR with compounds meeting Boeing's BMS 1-22 specification. This specification and AMS 3345 and 3346 were written around CHR's COHRlastic HT* high tear strength silicone rubber compounds. These CHR compounds, at the present, are the *only* stocks which will meet these specifications.

In the single year that these compounds have been available, a trend to designing with high tear strength silicone rubber has been established. Other airframe and engine companies are writing specs around CHR's compounds or specifying AMS 3345 and 3346 on new and revised prints.

CHR representatives calling on all major airframe and engine manufacturers are available for consultation on use of these compounds. Write or phone for specifications and samples of COHRlastic HT silicone rubber.



Seals produced by CHR for: (1) pilot's sliding window (2) passenger door (3) galley door (4) cargo hatch and (5) escape hatch are made with CHR's COHRlastic HT 666 silicone rubber meeting Boeing's BMS 1-22 specification. Other CHR silicone rubber seals are used throughout all 707 models.

*COHRlastic HT 665 and HT 666 are produced from high molecular weight gums reinforced with du Pont's Valron® estersil.

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Jonathan Kludt, executive vice president and general manager, Lincoln Engineering Co., St. Louis, Mo.

Paul Meeks, a vice president and a director, Clary Corp., San Gabriel, Calif. Mr. Meeks is general manager of Clary's Automatic Controls Division.

Lee S. Johnson, vice president of United Aircraft Corporation and general manager of Sikorsky Aircraft, appointed to the company's Operating and Policy Committee.

Edgar Schmued, corporate vice president (technical) of Northrop Aircraft, Inc., elected to the company's executive committee.

Clarence W. Miles, general counsel, The Martin Co., Baltimore, Md.

George B. Foote, treasurer, Baird-Atomic, Inc., Cambridge, Mass.

Peter J. Wacks, assistant to the president for industrial relations, Bell Aircraft Corp., Buffalo, N. Y.

Walter E. Bison, administrative assistant to the president for special projects, Lycoming Division, Avco Manufacturing Corp., Stratford, Conn.

James N. Davis, assistant to the president in charge of the Washington, D. C. office, Vertol Aircraft Corp., Morton, Pa. Mr. Davis replaces **T. R. Pierpont,** Vertol's service manager, who has been temporary head of the Washington office. Also: **William E. Boom,** European sales manager.

Jerome Zauderer, vice president, Bruno-New York Industries Corp., New York, N. Y.

George W. Gutekunst, C. H. Rieman and **Brice D. Maddox,** vice presidents, Gardner-Denver Co., Quincy, Ill.

Armando Perez Plasencia, vice president, Cubana Airlines.

A. E. Smick, assistant vice president, aircraft maintenance (Tulsa, Okla.), American Airlines, Inc.

Honors and Elections

Lawrence A. Hyland, vice president and general manager of Hughes Aircraft Company, was presented The 1957 Pioneer Award by the Institute of Radio Engineers' professional group on aeronautical and navigational electronics in recognition of his "direct contributions to airborne and navigational electronics through research and inventions in the fields of direction finding, altimetry, ignition shielding and radar . . ."

Thomas A. Harvie, senior project engineer at Canadair Limited, has been awarded a year's fellowship in the executive development program of the School of Industrial Management at Massachusetts Institute of Technology.

Rear Adm. Selden B. Spangler, USN, Commander, U. S. Naval Air Development and Material Center, Johnsville, Pa. has been elected a Fellow of the Royal Aeronautical Society, one of England's highest aviation honors.

INDUSTRY OBSERVER

► Curtiss-Wright will produce the 20,000 lb. thrust Iroquois axial flow turbojet engine under a licensing agreement with Orenda Engines Ltd. of Canada. Formal announcement of the agreement probably will be made within the next few weeks.

► **Grumman Aircraft is considering production of a jet executive transport powered by Rolls-Royce Dart turbojet engines. Presently planned target date for first deliveries is the fall of 1958.**

► Russia's Bison heavy jet bomber has been equipped with a retractable refueling probe. Effective range, with two refuelings, is about 8,800 mi.

► **Aerojet solid propellant rocket engine for Navy's Polaris intermediate range ballistic missile has completed successful static test firings at Aerojet's Sacramento plant. Unit is the largest solid propellant rocket engine built in the U. S. thus far.**

► Lockheed Missile Systems Division's work on the fuselage for Navy's Polaris IRBM plus a number of other new missile design activities have been moved from the Van Nuys, Calif., facility to Sunnyvale, Calif. Van Nuys will continue to do some missile design as well as work on guidance system designs for Lockheed and other companies.

► **Republic Aviation is constructing a tandem version of its F-105 Thunderchief for use as an Air Force trainer. Designation is F-105C.**

► Passive radar, a new technique developed for airborne surveillance and mapping, is essentially a hybrid between conventional radar and infrared, incorporating radiometry techniques developed originally for radio astronomy. Such systems detect electromagnetic energy radiated by all objects above absolute zero temperature similar to infrared but at longer millimeter and centimeter wavelengths in the microwave region. Radiometric, or passive radar, also has greater range than infrared, can spot targets which may elude the latter. Response time is slower, however.

► **Warning device to indicate incipient pitchup condition in very high speed and altitude regimes is being installed on the Lockheed F-104. Stick will automatically correct even if pilot fails to notice warning.**

► Germanium transistors capable of operating at frequencies as high as 1,120 megacycles, a point considerably beyond previous frequency limits, have been fabricated experimentally by Bell Telephone Laboratories using a diffusion process.

► **Army is asking industry to submit proposals for a tactical missile with a range of 750 mi., 550 mi. beyond the range limit imposed on the service by Defense Secretary Charles E. Wilson's memorandum of understanding (AW Dec. 3, p. 30). Army feels that once it has such a missile on hand it can persuade Defense of its need to keep it.**

► Bell H-40 helicopter can carry a total of 12 troops in two external pods attached to either side of the fuselage. Normal internal load of the Army helicopter is five. Because of its narrow fuselage, four H-40s can be stored and carried in a medium fixed-wing cargo plane. Army hopes to have the helicopter ready for operational service within the near future.

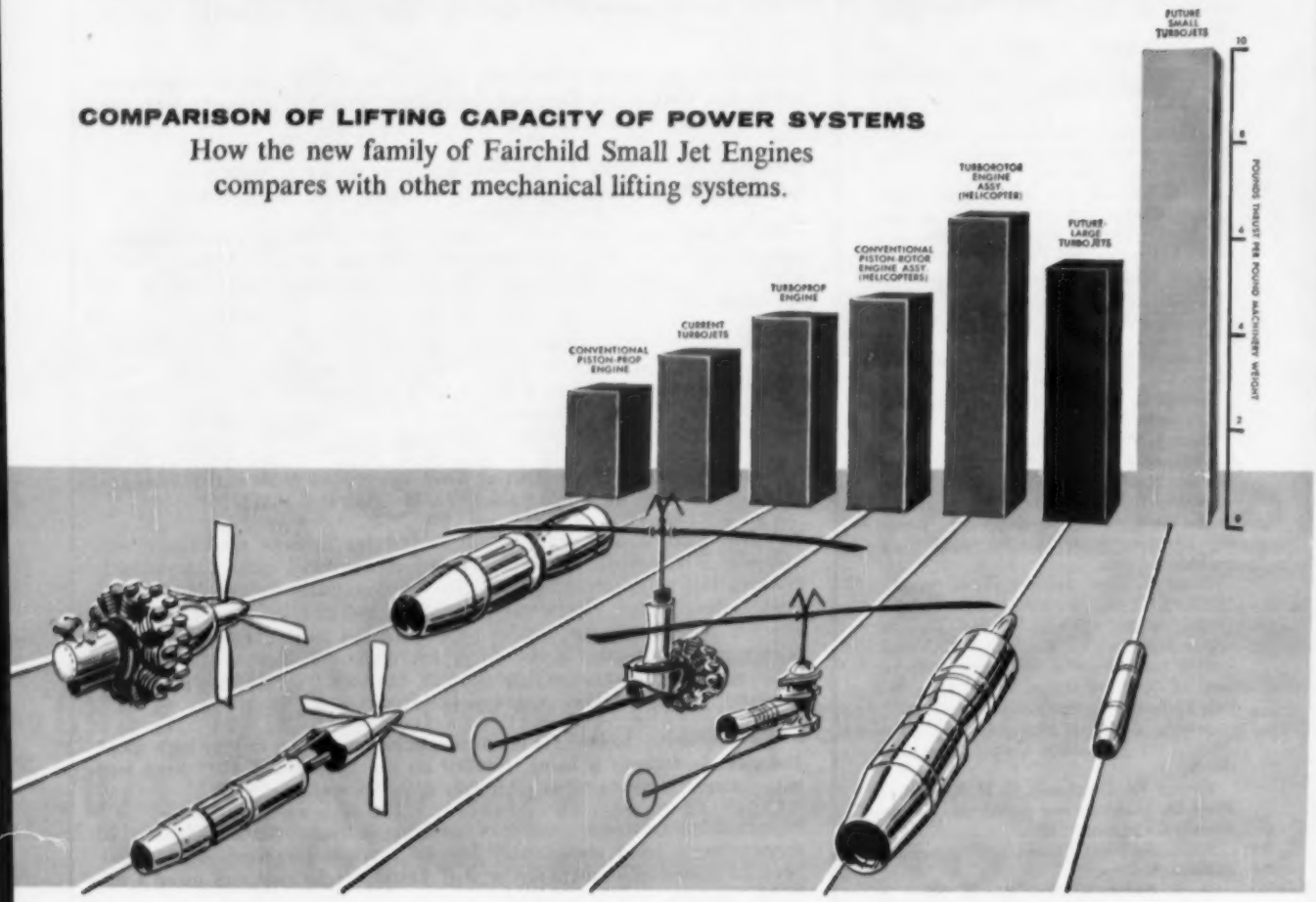
► **Dassault is preparing a ramp takeoff device for its Mirage III interceptor and fighter using a zero-length launcher. Launching device is similar to the one used by Martin's Matador missile. Two JATO units of approximately 13,000 lb. thrust each and with a firing duration of two and one-half seconds will provide power for the launch. The present Mirage III has flown at Mach 1.6. Later model will have an Atar 9 engine of over 13,000 lb. thrust, replacing the present 9,600 lb. Atar 8, and is expected to fly at Mach. 2.**

► Navy is asking for $3.2 million during Fiscal 1958 to equip aircraft carriers and shore bases with mirror landing systems which already have substantially cut the Navy's aircraft accident rate (AW May 20, p. 23).

SMALL JET ENGINES... CHAMPION WEIGHT LIFTERS

COMPARISON OF LIFTING CAPACITY OF POWER SYSTEMS

How the new family of Fairchild Small Jet Engines compares with other mechanical lifting systems.



An entirely new family of aircraft will evolve from a new family of small lightweight jet engines now under development at the Fairchild Engine Division. These new powerplants will feature incredibly high thrusts and great lifting power . . . yet will be so light they can easily be carried by two men.

Highly compact, with low frontal areas, the small jet engines will deliver thrust/weight ratios starting at 8 to 1 with a long range potential of more than 10 to 1. They will be used in the high performance, lightweight trainers, interceptors, target drones, pilotless aircraft including missiles and intermediate class passenger and cargo jets of the nineteen sixties. They will also be used to power fighters and utility cargo craft, executive aircraft . . . and will make jet Short Take Off and Landing (STOL) and Vertical Take Off and Landing (VTOL) aircraft practical.

The small jet engine may be used singly, in pairs and in clusters. It provides multi-engine reliability in aircraft of a size now wholly dependent on a single engine. The small jet engine will produce greater versatility and utility in airplanes of tomorrow.

The extensive research facilities at Fairchild Engine Division have been designed solely to test performance of the small jet engine. They range from full scale, high altitude test chambers to supersonic research for component design. Fairchild Engine Division has spent a decade in the design, development and production of small, powerful jet engines.

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Washington Roundup

Curtis Successor: Quesada

Look for Lt. Gen. Elwood Quesada (USAF, ret.) to replace Edward P. Curtis as special assistant to the president for aviation facilities planning. A former vice president and general manager of the Missiles System Division of Lockheed Aircraft Corp., Gen. Quesada is being recommended for the post by Curtis who plans to return to his former position as vice president of Eastman Kodak Co., sometime next month.

Gen. Quesada, a career military aviation officer, was chairman of the joint technical planning commission of the Joint Chiefs of Staff prior to his retirement from service. Earlier, he was commanding general of the Tactical Air Command and, during World War II, was assistant chief of air staff-intelligence, commanding general of the Ninth Tactical Air Command and commander of the Ninth Fighter command in addition to several other positions. At present, Gen. Quesada lists himself as being self-employed.

Third Abort for Thor

Despite Air Force attempts to make such events matters of state secret, 1,200 persons lined the beaches near Patrick AFB, Fla., one night last week to watch USAF's third attempt at launching a Douglas Thor intermediate range ballistic missile. What they saw and heard were two spectacular explosions followed by a huge ball of fire. The Thor had been destroyed on its pad moments before it was to be launched. Fuel spillage had touched off a fire, and the explosion followed. The Air Force later admitted there had been a fire and explosion but refused to say just which missile was involved. First two Thors aborted after launch.

Satellite Delay

Outlook now is that the first launching of an instrumented earth satellite, originally slated for this September, will be delayed up to a year.

Richard W. Porter, chairman of National Science Foundation's technical panel on the Vanguard program, reported to House Appropriations Committee that there will be launchings . . . and there is a probability of at least one successful launching . . . before the end of 1958." The overall program is to fire six fully instrumented satellites.

On the lifetime of a satellite, Porter said, "It will certainly not be less than a few weeks, nor more than a few years. We sincerely hope that more than one . . . would be launched successfully."

'Leak' Legislation

Sen. Henry Jackson (D.-Wash.) is pushing legislation that would provide criminal penalties for both Civil Aeronautics Board employes who "leak" confidential information and for individuals who attempt to "pressure" Board members. CAB Chairman James R. Durfee endorses such a proposal which also would apply to other quasi-judicial agencies.

In Congress

Watch for early congressional action on the proposal of special Presidential Assistant Edward P. Curtis for the establishment of a three-member Airways Modernization Board (AW Apr. 8, p. 26). Senate Commerce Committee plans to conclude hearings today on opposition testimony by Air Line Pilots Assn. (AW May 20, p. 26). House Commerce Committee will begin hearings June 5.

Legislation authorizing permanent certificates for U. S. Alaska carriers approved last week by Senate Commerce Committee is expected to run into opposition in the House again this year. The Senate approved the measure last session. Carriers affected are Pacific Northern Airlines, Alaska Airlines, and Northwest Airlines.

Declassification Boss

New post of Director of Declassification Policy has been created under Assistant Secretary Murray Snyder, former White House press officer.

The director: Rear Admiral John M. Hoskins, president of the Naval Examining and Physical Disability Board, who is scheduled to retire from active duty and take over the new office. Defense Secretary Charles E. Wilson says Admiral Hoskins will be responsible for "development, interpretation and dissemination of policy" regarding downgrading and declassification of material. New job was recommended by Coolidge Committee in its recent report on Defense public information policies.

Power to SAC

USAF's Lt. Gen. Thomas S. Power was formally nominated last week to succeed Gen. Curtis LeMay as commander of the Strategic Air Command, as predicted by AVIATION WEEK on May 13 (p. 25).

The White House also called for the promotion of Power to the rank of full general. Gen LeMay has been promoted to USAF vice chief of staff.

Lt. Gen. Frank F. Everest also was recommended for promotion to full general and for duty as commander of U. S. Air Forces in Europe, a move also predicted by AVIATION WEEK.

In Europe, Gen. Everest will replace Lt. Gen. William H. Tunner, who, in turn, will replace Gen. Everest as deputy chief of staff, operations, at the Pentagon.

To replace Gen. Power as head of the Air Research and Development Command, President Eisenhower nominated Lt. Gen. Samuel E. Anderson, present director of the Weapons System Evaluation Group attached to the Office of the Secretary of Defense.

Other USAF appointments:

- **Maj. Gen William E. Hall,** from duty as assistant chief of staff for Reserve Forces, USAF, to commander, Continental Air Command and senior Air Force member, Military Staff Committee of the United Nations.
- **Maj. Gen. Walter E. Todd,** from duty as vice commander and chief of staff, Far East Air Forces, to chief of staff, United Nations Command, Korea.
- **Maj. Gen. John K. Gerhart,** from duty as commander of the Twelfth Air Force, United States Air Forces in Europe, to deputy chief of staff, plans and programs, USAF.
- **Lt. Gen. M. J. Asensio,** from duty as deputy chief of staff comptroller, USAF, to comptroller.
- **Maj. Gen. Robert B. Landry** to assistant deputy chief of staff, personnel, replacing Maj. Gen. William S. Stone.

—Washington Staff

Subcontractors Face Stiffer Competition

Military anticipates fewer primes, excess space, as emphasis swings from airframes to missiles.

By Claude Witze

Washington—There is increasing and undeniable recognition that excess facilities and sub-contracting structures will harass the U.S. aircraft industry and military services within the next three years.

With Congress, the administration and Defense Department more alert to economy than they have been since the post-war retrenchment epitomized by Louis Johnson, airframe and component manufacturers will see the existing policies and structures of military procurement drastically revised.

On top of the cry to save money, there are the cruel facts that stem from increasing emphasis upon missile warfare. In addition to growing complexity and an absolute necessity for perfect reliability, the size and style of the weapon system has changed the entire market for aircraft industry real estate and machinery.

Airframe Decline

The Air Force, for example, is publicizing figures that demonstrate the magnitude of the problem. Maj. Gen. David H. Baker, director of procurement and production for the Air Materiel Command, has called attention to these estimates:

• **At present,** industry produces 5 million lb. of airframes and missile frames a month. Early in 1958, it will hit a peak of 6.5 million lb. a month. Then it will drop to 2.5 million lb. and stay at that rate through 1962.

• **USAF contractors** today have 60 million sq. ft. of space. About 20 million of this is excess to today's requirements. By 1960, 10 million sq. ft. of new capacity will be added, but there will be 50 million sq. ft. of idle space.

For all contractors, Gen. Baker warns that, in the future, USAF will buy a smaller number of weapon systems, involving fewer prime contractors. It follows that the subcontractors will find "a steadily narrowing span of opportunity for their products and services."

Realization that these facts must be faced has led top AMC officers to serious study of present policies and to conjecture over possible changes.

Most likely prospect: Relaxation of the current insistence that at least 30% of the weapon system dollars go to subcontractors.

Actually, the rate of subcontracting by USAF primes has been declining steadily since 1952, when it stood at about 35%. AMC realizes that major manufacturers are inclined to favor sub-contracting only when there is a high level of orders, that "subcontracting follows appropriations" in most important projects.

By digging into the records, they are able to prove that economies are possible mainly when the prime contractor has the space, talent and inclination to build more of the system himself.

Classic Example

Classic example probably comes from the early days of the Douglas C-124 transport. A production contract signed late in 1952 provided Douglas with a fixed fee of 6% and carried an estimate that $61.5 million would be passed along to the company's subcontractors.

Later, the manufacturer decided to utilize more space in Douglas plants, along with the machinery and manpower already on hand. The subcontract level was slashed $45.9 million, down to $15.6. This work, which estimates said would cost $45.9 million from subcontractors, was done by Douglas for $10.4 million.

The saving claimed by Douglas for USAF: $35.5 million.

Reviewing this item of history in the light of upcoming industry-AMC problems, it has been pointed out that the work retained by Douglas on the C-124 contract involved those jobs requiring technical know-how and special skills, such as fabrication of tools and parts. Only the simple tasks were delegated to subcontractors.

Experiences of this type are common in the record, and they will be cited as an argument that the prime contractor should retain more of the fabrication in his own plant if it is necessary to his economic survival and does not jeopardize the production capability of the nation.

Among the other inevitabilities of the future as seen by some procurement officials:

• **Approval of fast tax amortization** proposals will get more difficult as the Defense Department strains to hold down the excess floor space and facilities. A new project will have to be proven essential.

• **Increasing amount** of government-owned machine tools will lie idle.

• **New subcontracting policies** must be established to keep a reasonable number of highly-competent component makers busy but recognize at the same time that the prime contractors have new and sound arguments for entering the component field.

Primes' Electronic Effort

In the latter connection, it will be argued that much of the already-accomplished entrance of major airframe makers into such fields as electronics came about because the firms were pushed into this activity (see p. 37).

To some degree, it is maintained, this was necessary to keep busy. To a greater one, it was necessary because 10 years ago the specialists were too busy with their commercial backlog and defense production to concern themselves with research and development looking toward today's weapon systems.

On top of this, there are cases where the airframe makers have surpassed the equipment industry in their ability to produce certain components.

Gen. Baker says all future decisions by AMC, when it comes to revising policies and realigning emphasis, will be made on a basis of cost. He says AMC also will evaluate production expansibility and capital investment in plants when it determines future subcontracting policy.

He has warned the electronics industry that its products will grow in complexity and require a greater total effort and adds:

"A large section of the specialized industry has adopted a policy of wait and see with respect to working with prime weapon systems manufacturers.

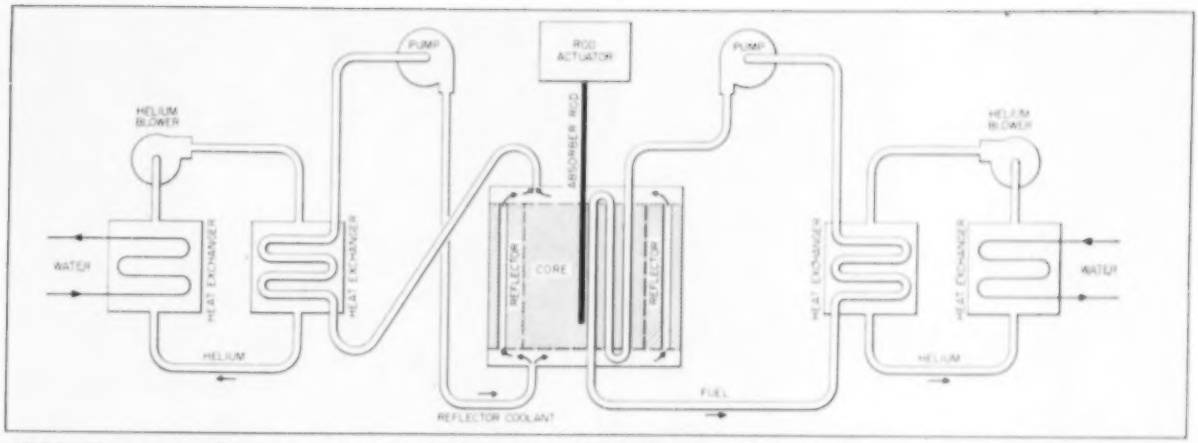
"The trend to fewer systems and fewer prime contractors should be examined closely by these people, and appropriate plans and action taken or they may find themselves precluded from the future systems market."

Manufacturers Warned

Chicago—Electronic equipment manufacturers are being warned by the Air Force that it will not buy weapon system components that have not been engineered and tested for reliability.

In future competitions, according to Maj. Gen. David H. Baker, of the Air Materiel Command, "The blue ribbon will go to the company which has recognized reliability as the prime requisite in its product."

Gen. Baker said the transition to guided missiles is being hampered by a lack of electronic reliability and that unless the industry does something about it, USAF will lose its technical superiority.



AIRCRAFT reactor flow diagram shows how the Oak Ridge National Laboratory liquid-fuel system was set up for its experimental 10 day run. The three foot diameter reactor is in the center. The right hand flow loop was for recirculating the liquid fuel through the reactor core. The left hand flow loop was for cooling the reactor reflector. The helium loops were used to step down the cooling temperatures for the water. In actual aircraft nuclear propulsion, the engine airflow would be fed into the heat exchangers instead of helium. The heat exchangers would substitute for the fuel combustors.

Open Cycle Takes Nuclear Engine Lead

By Robert Cushman

New York—USAF has put half of the $200 million left of its aircraft nuclear propulsion funding for next year into General Electric's open cycle X211 project, handled by GE's Aircraft Nuclear Propulsion Department, Evendale, Ohio.

Pratt & Whitney has had its share cut due to complications, probably heat transfer, met in its closed cycle nuclear engine project, designated J91. The J91 is described as a large low temperature, and consequently low performance, engine.

One nuclear consulting firm told AVIATION WEEK all its aircraft program business now is with GE.

GE, following the successful running of four modified J73 turbojets hooked to an open cycle reactor (AW Mar. 18, p. 27), has transferred some of its top men from the jet engine departments into the X211 nuclear project. GE also has increased its staff at Arco, Idaho, where running of experimental engine configurations is continuing.

The difference between the GE open and the P&W closed cycle approach is this:

- **GE flows** the turbojet's compressor discharge air directly through ducting in and around the reactor to pick up the heat.
- **Pratt & Whitney** flows the compressor discharge air through an intermediate heat exchanger where the air picks up heat from a liquid (liquid sodium has been frequently mentioned) which has been pumped in closed circuit through the reactor.

Basically the problem is that even subsonic turbojets need 1,200F air going into their turbines. By elementary laws of heat transfer this means that the metal which separates the liquid from the air in the heat exchangers must be at higher temperatures for heat will only flow downhill.

For supersonic engines, where air temperatures of 2,000F ought to be going into the turbines, the problem is well beyond the stage of heat exchanger materials art.

Present chemically fueled turbojets only operate successfully because fuel is burned right in the airflow so that the metal surfaces can be protected by thin films of cooling air.

This problem of cycle temperature for nuclear propulsion systems works hand in hand with shielding weight. Unless hotter cycles can be run, the nuclear system can't develop the power-to-engine-weight ratio to lift the additional shielding load. One hopeful aspect, however, is that nuclear fuel amounts to negligible weight penalty and the nuclear engine could run at hotter, more powerful output levels than those dictated by optimum fuel consumption.

P&W Reactor Approach

Because of the lowered priority of the P&W project, details of one type of reactor which P&W has been interested have been revealed. Dr. Alvin M. Winberg, director of the Oak Ridge National Laboratory, described an experimental aircraft reactor tested three years ago before a recent Inter-American Symposium on the Peaceful Applications of Nuclear Energy, Brookhaven National Laboratory, Long Island, N. Y. It can be assumed that this reactor, a closed loop type, had some relationship to the known joint efforts of P&W and Oak Ridge.

Weinberg described a circulating-fuel closed loop reactor which used a mixture of molten fluoride salts containing uranium-235. It operated at 1,500 F temperatures continuously for 4 days in November of 1954. While these temperatures are very high for nuclear reactors (and make this chemical-type reactor attractive for aircraft applications) they are only moderate by turbojet standards, especially when it is considered that they are one step removed by the heat exchanger from the actual engine air cycle.

How It Works

As the flow diagram shows, the molten fluoride fuel was pumped by means of a high temperature centrifugal pump through the reactor inside a complex of serpentine shaped nickel alloy tubes.

Molten mixture of fluoride salts was kept well over its melting point of 900F and the UF_4 fuel was carried along as part of the mixture, not suspended in a slurry as in other types of liquid fuel cycles. The mixture was not critical outside the reactor due to the neutron capturing action of the fuel and piping. But when it entered the beryllium oxide core of the reactors, the fuel became critical since beryllium oxide does not absorb neutrons, and the fission process started to release heat energy.

To keep this energy under control heat was removed both from the reflector and the core. The fuel loop was used to carry heat from the core while another loop of circulating sodium carried heat from the reflector. The

PLAN VIEW of competition winner shows characteristic Grumman wing shape.

Grumman Design Wins Contract

Washington – Grumman Aircraft Engineering Corp., Bethpage, L. I., has won the joint Army-Navy competition for a new higher performance observation airplane designed for use by the Army and Marines.

Scheduled to fly in 1959, the Grumman design is conventional with the exception that cockpit visibility is improved over most aircraft of this type. The aircraft will carry a pilot and observer in side-by-side seats. If required, space and weight allowance for the observer can be filled by electronic equipment for surveillance missions.

The new aircraft will be powered by two Lycoming T53 turboprop engines. No performance figures have been disclosed, but Army requirements called for an aircraft with STOL capabilities, a speed of 275 to 300 knots. The Grumman plane and the T53 engine were selected unanimously by independent Army and Navy evaluation groups.

Navy is the procuring agent and is expected to purchase production models for the Marines before a decision is made on whether Army will be permitted to put the aircraft in operation.

Once this is approved, procurement for the Army probably will exceed Marine requirements.

LYCOMING T53 turboprops will power Grumman observation plane (model shown).

heat from both these loops was extracted by a helium "buffer" loop from which, in turn it was rejected to water.

The only control necessary was a stainless steel regulating rod which could be let down through the center of the reactor to absorb varying degrees of neutrons and three boron-carbide safety rods.

Active Region

The active region of the reactor was described by Weinberg as a right circular cylinder 33.3 in. diameter and 35.8 in. high. The BeO reflector to keep the neutrons active inside for efficient fission was 7.4 in. thick. The critical mass was 14.9 kilograms of uranium-235; the total mass of uranium-235 in the whole system (counting external piping loop as well as core plumbing) was approximately 66 kilograms. The flow velocity of the reactor was 1 meter per second; the Reynolds number was 10,000.

Design power of the reactor was to have been 1,500 kw. but it actually ran at a peak output of 2,500 kw. Since this amounted to 3,350 hp. or less than 3,000 lb. thrust, this experimental reactor was not powerful enough to fly itself.

The exit temperature of the fuel from the reactor to the heat exchanger was 1,500F. At this temperature it glowed a dull red. The inlet temperature of the fuel was about 1,200F, indicating roughly the low values for the maximum turbojet cycle temperature.

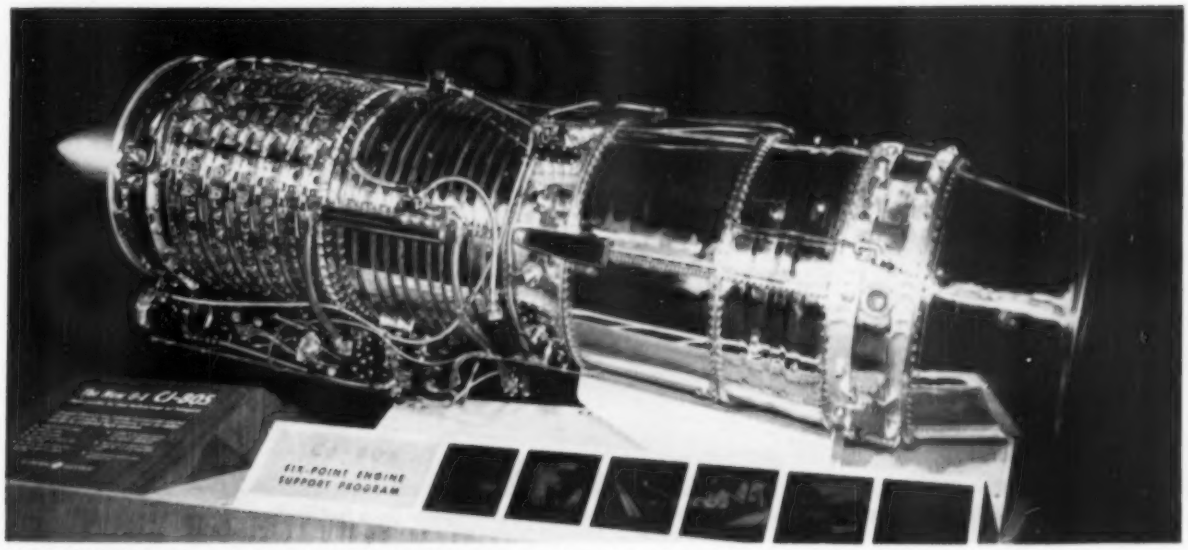
After the short experimental turn, the reactor was shut down and has since been dismantled.

Extreme stability is one of the virtues claimed for this type of reactor. Weinberg said that it was completely power-demand responsive and the control was mainly done by manipulating the flow of cooling helium gas to the heat exchangers. The control rods were used for setting the operating temperature level.

Corrosive Action

Main problem appeared to be maintaining absolute leak-tightness despite the very corrosive action of the fluoride salts at the high temperatures. Weinberg said that even during the short life of the test reactor there was a very small leak from the gas volume above the liquid surface of the fuel pumps which made operation awkward.

In his talk before the symposium, Weinberg was advocating that this type of reactor should be considered for stationary power generating plants on the ground. Therefore it is the installed weight rather than the operating qualities of this type of reactor which prevent it from being as attractive as open cycle system for aircraft at the present time.



CHROME-PLATED General Electric CJ805 turbojet, commercial version of the J79, is shown displayed at the Paris Air Show.

Low Lead Time, Lightness Mark J79

By J. S. Butz, Jr.

Evendale, Ohio—General Electric's Mach 2-plus J79 turbojet, which provides considerably more than 15,000 lb. of thrust with afterburning at a total engine weight of less than 3,200 lb., took only 3½ years to develop.

It embodies a previously unused mechanical principle in its compressor —the variable stator—which GE credits with great weight reduction while allowing high compression ratios and efficient operation over the whole operating range of the engine.

Its versatility has been demonstrated in use or scheduled use without basic modification in fighters, bomber, missiles, and commercial transports. It has aroused great interest in Europe as well as in this country.

First Display

The J79 was shown publicly for the first time last week in Washington, when a recently overhauled engine from the F-104 program was displayed. Later in the week its civil counterpart the CJ805 had an initial unveiling prior to the 22nd Paris Air Show of the Society of French Aircraft Constructors, where it is currently being shown.

That the engine is technically a very advanced powerplant is equalled in significance by its low lead time. The J79 is clear proof that jet engine design is becoming more of a science. Its 3½ year development time is a reduction of at least 30% over average development time of recent engines.

The J79 project was formed in January, 1953 when the Air Force laid down its specifications. In February, 1956, the F-104 made its first flight and it was powered by a J79. The engine was actually used as the sole powerplant in an aircraft as early as December, 1955, when it powered an F4D. The J79 passed its 150 hr. flight rating test in August, 1956, which ended its testing to qualify for production.

Neil Burgess, manager of the J79 project, attributes this major reduction in lead time to several factors:

- **Multi-million dollar** GE owned test facilities located at the Evendale plant with easy access for the design groups. Over 90% of the ground testing was accomplished there.
- **General improvement** in instrumentation techniques allowing use of strain gages, transducers, etc. in large numbers and at very high temperatures.
- **Automatic data reduction** equipment capable of correcting test data in a day instead of weeks.
- **Growing backlog** of experience in jet engine design.

U. S. Position

Development by an American company of a thoroughly advanced engine in only 3½ years is significant, especially since most U. S. engine companies were producing British-originated designs less than 10 years ago. As indicated by Burgess, this progress was made possible in large part by the availability of complex and expensive development facilities to speed and expand test programs.

General Electric and its major U. S. competitor, Pratt & Whitney, have private development establishments unmatched anywhere in the world. GE, for instance, has nearly $100 million invested in laboratories for its Aircraft Gas Turbine Division, and spends approximately $15 million a year for expansion and improvement of these facilities.

Technical Details

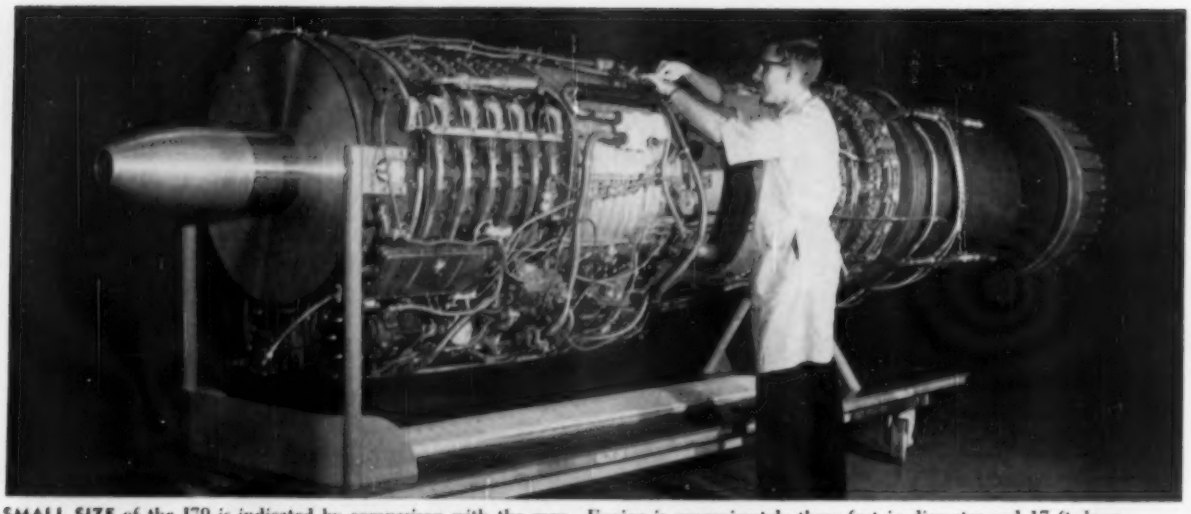
The J79 develops slightly more than 10,000 lb. of thrust without afterburner, and its total weight of less than 3,200 lb. with the afterburner unit is less than that of a basic J47 engine.

GE officials describe the afterburner as having the highest augmentation ratio of any afterburner developed to date.

This would indicate that it increases the basic engine thrust by a good deal more than 50%. Obtaining 17,000 to 18,000 lb. of thrust from less than 3,200 lb. of engine weight would explain the excellent speed and altitude performance of such aircraft as the F-104, F11F-1F, and the B-58, all J79 powered.

Air is taken into the afterburner nozzle, probably for more than cooling purposes, possibly for giving an aerodynamic means of changing nozzle geometry. Proprietary rights are important considerations of the J79 and there are reported to have been five major patent applications made concerning systems on the J79.

Most important GE effort to reduce engine weight was in the basic approach to compressor design. There are three known methods for preventing recirculation of air out of the engine inlet and compressor stall on high-speed engines during low-speed opera-



SMALL SIZE of the J79 is indicated by comparison with the man. Engine is approximately three feet in diameter and 17 ft. long.

tion. They are the use of twin-spool compressors, bleed valves on the aft stages of the compressor, or variable stator blades on the first stages.

GE is the first company to apply the variable stator on an actual engine. The decision to use this design was made after separate groups had studied the two most efficient methods, the twin-spool compressor and the variable stator. A review of the separate studies convinced GE that the variable stator would allow sizeable weight savings while maintaining the desired ruggedness and strength of the compressor. The variable stator permitted the use of only one shaft and three main bearings compared to two shafts and nine main bearings required by the twin-spool proposal. Weight was further reduced by using a conical instead of a cylindrical shaft to tie the compressor to the three stage turbine.

The compressor now on the engine has 17 stages with variable inlet guide vanes and variable stators on the first stages. It is described by GE as having a very high compression ratio for good sonic cruise at low specific fuel consumption. It would then follow that the turbine inlet temperatures are high to give a minimum SFC.

Control mechanism for the variable stator mechanism is integrated with the main fuel control. Therefore the stator is probably positioned by sensing engine rpm. and turbine inlet temperature.

The power control system for the engine ties together the main fuel system, the afterburner fuel system, nozzle area control, and variable stator control. This integrated system uses hydraulic-mechanical power with electrical trim.

The engine's construction is simple with split turbine and compressor housings for easy access. The turbine housing is sheet steel, as are many of the other parts, and may be fabricated by stamping. There is no titanium or other expensive material in the engine, which was designed toward low-cost and ease of manufacture.

The J79 test program is a definite indication of the comparatively trouble-free development period of the engine, and the growing rate at which definite design knowledge is replacing cut and try methods.

The first official test that faces a new engine is the 50 hr. flight rating test. The Air Force estimates that 2,000 hr. of factory testing precedes the successful completion of this test. The J79 passed it after only 1,600 hr. of prior running.

The engine performed so well that GE was able to fly it as the sole power in an F4D providing high-speed flight test data two months before the first flight of the F-104. Before that, flight-test information was obtained at lower Mach numbers by slinging the engine under North American B-45. The test program continued just as favorably during F-104 flights.

The last step was the Air Force 150 hr. test which precedes production orders for an engine. This is usually attempted after 10,000 hr. of prior running, but the J79 passed after 6,500 hr.

J. S. Parker, general manager of the GE Aircraft Gas Turbine Division, recently stated that the original development schedule was cut by a month, changes in specifications notwithstanding. It seems then that the rapid J79 development was not an accident and that lead times for turbojet engines may be held well below those for airframes.

The CJ805 commercial engine is exactly the same engine as the J79 except that the afterburner has been removed and the variable area nozzle has been replaced with one of fixed area. The area on this nozzle is designed to give maximum specific fuel consumption at cruise speed and altitude, limiting take-off thrust somewhat.

General Electric has high hopes for this engine in the medium range class of jet transports. It has already been specified to power the Convair 880 at a maximum cruise speed of 615 mph., which is the fastest announced for any new transport. The engine may also be used, at airline option, in the French Caravelle, and the small version of both the Boeing 707 and the Douglas DC-8.

GE estimates that the market for medium-range jets will eventually be larger than the long-range transports. This campaign is also on in Europe where medium range aircraft are practically the whole market. GE feels that if none of the European governments subsidizes a rival engine, the CJ805 will be able to compete on that continent.

This competition is based, of course, on the initial cost, engine performance, ease and cost of obtaining spares, lengths and types of warranties and guarantees, and the cost of maintenance. General Electric has guaranteed a maximum parts cost of $22 per flying hour per engine for overhaul and line maintainance on a fleet basis for two years after initial airplane delivery.

Overhaul will require 750 manhours. This estimate is based on experience with the J47 during factory overhaul at the GE plant. Line maintenance is estimated to require .5 man-hours per engine flying hour. Time between overhauls is predicted to be high in light of previous GE success in this department. The J47, for instance, has the highest time between overhauls of any axial-flow turbojet, which is 1,700 hours.

Growth and derated versions of the CJ805 are being planned so that a wider variety of applications may be considered for the engine.

House Group Cuts USAF $670 Million

By Katherine Johnsen

Washington—House Appropriations Committee last week clipped $670 million from USAF's Fiscal 1958 budget requests and another $144 million from naval aviation in the first concrete step by an economy-bent Congress to hold down defense costs.

The outlook is that as the administration's overall $36 billion Defense Department budget—now cut by the House committee to $33.5 billion—moves through the House and Senate, additional attempts will be made to make even further reductions.

The three basic reasons that were given by the House group for its reductions were:

- **Russian threat has "abated"** according to revised U. S. intelligence reports.
- **Much money can be saved** by tightening loose procurement policies.
- **Present inter-service rivalry,** particularly in the guided missile field, is not only costly but "is becoming so serious as to jeopardize and delay the rate of build-up."

Military Procurement Funds

Funds approved by the House Appropriations Committee for Fiscal 1958 procurement of aircraft and related materiel by the Air Force and Navy, as compared with the Fiscal 1957 allocation and the administration's request for Fiscal 1958:

AIR FORCE
(In Millions)

	FY 1957 Budget	FY 1958 Request	FY 1958 Allowed by House Committee
Aircraft and Related Procurement			
Total Appropriation (New Funds)	$6,848	$6,200	$5,846
Coupled With Prior Year Funds This Provides for:			
Aircraft Complete	3,414	2,719	2,719
Aircraft Spares	2,567	2,359	2,164
Guided Missiles, Complete	1,676	1,415	1,345
Guided Missile Spares	119	106	101
Industrial Facilities and Equipment	333	300	300
Modification of Equipment	622	633	550
NAVY			
Aircraft and Related Procurement			
Total Appropriation (New Funds)	1,733	1,932	1,812

What Committee Approved

The $15.8 billion USAF budget approved by the committee includes:

- **Aircraft and related procurement,** $5.8 billion, a $354 million cut in the administration's request and $1 billion below the Fiscal 1957 allocation.
- **Research and development,** $649 million, a reduction of $12 million in the administration request was made, the committee said, "for the purpose of emphasizing that all possible economies should be effected," but it is $61 million below the Fiscal 1957 allocation.

The committee also made a $162 million reduction in USAF's operational costs, largely by directing a cutback of 500,000 planned flying hours over the coming year, commenting that it "especially deplores the 'junketing' that is done under the guise of so-called proficiency flying."

A $100 million reduction in USAF's non-aircraft procurement funds was aimed at "moving a little slower" with the Semi-Automatic Ground Environment System (SAGE) and the Aircraft Control and Warning Program. Stretchouts of these programs, the committee said, "should result in the long run in a much more effective system."

The cuts were promptly challenged by Defense Secretary Charles E. Wilson who said "they represent adjustments downward in our defense program of considerable magnitude and seriousness" that "amount to gambling unwisely with the security of the nation."

Wilson told the Senate Appropriations Committee the Defense Department already had "drastically" reduced fund requests for research and development programs and that any further cuts "cannot be justified."

The $2,665 million budget approved for naval aviation—including funds for both aircraft and related procurement and operations—is $122 million above the Fiscal 1957 allocation but a $144 million reduction in the administration request.

The Fiscal 1958 program, which the committee said will not be affected by its reductions, calls for procurement of 2,735 aircraft—1,220 by Navy and 1,515 by USAF.

On guided missiles the committee said it deplores "the lack of timely, effective, and decisive action" by Defense Secretary Wilson to achieve "a well-rounded, coordinated program at minimum cost."

Inter-service rivalry, it added, "seems to have begun with the desire on the part of each service to control the 'ultimate weapon,' the ballistic missile. . . . It is almost certain that tensions between services will mount as development of missiles advances to the point where they can be employed from any part of the world, either land-based or water-based. . . . Each service, it would seem, is striving to acquire an arsenal of weapons complete in itself to carry out any and all possible missions."

The committee said, "This matter of rivalry is getting completely out of control. It is expensive and undesirable, and points up the urgent need for more effective control and direction."

Guided Missile Cut

Specifically commenting upon its action in cutting $75 million from USAF's request for guided missile and parts procurement, the committee said that "much of Air Force's effort has proved to be of a duplicative and questionable nature."

It was stipulated, however, that none of the cut should be applied to the ballistic missile programs. But even these—the Atlas, Titan, and Thor programs—should be re-evaluated, the committee said. The total of $1.4-billion approved for guided missile and parts procurement compares with $1.8-billion for Fiscal 1957.

The committee singled out USAF's Bell Rascal missile program for a cutback, noting that "the Defense Department agrees that this particular missile is in the marginal area."

The committee termed Defense Department procurement "the most lucrative field by far for sizable and real savings."

It agreed that the complexity of military weapons makes it necessary to obtain a large portion of procurement by negotiation but added:

"However, this should not be used to hide or explain away waste and extravagance resulting from lack of effective controls throughout every stage of the procurement process."

U. S. Aims Sales Effort at Paris Show

Paris—U. S. aircraft industry indicated its strong interest in European markets by participation in the 22nd Paris International Air Show of most major U.S. manufacturers. Show, which opened last week, runs until June 2.

Twelve nations in addition to France exhibited. Russian participation was sought, but the French were still waiting for an answer as the time for the show opening drew near. Only Iron Curtain countries exhibiting were Czechoslovakia and Poland, and they confined displays to pleasure aircraft.

USAF Display

General Electric used the occasion to exhibit its CJ805 engine, commercial version of the J79, for the first time in Europe. GE was one of 200 exhibitors, and the U. S. participation gave the show a truly international, not just European, flavor.

USAF participation in flight displays this weekend will not be as spectacular as French authorities had hoped. French had been half promised Lockheed F-104 Starfighter and KC-135 tanker. Demonstration of inflight fueling of B-52 by jet tanker also had been announced, but USAF confirmation had not come through by showtime.

USAF participation will include F-100 Super Sabre aerobatic team which will compete with British RAF Hawker Hunter team and two French aerobatic teams, one composed of Mystere IVAs and the other Fouga Magister jet trainers.

Also included in the exhibits are: Boeing KC-97 tanker, Lockheed C-130, North American B-66, Douglas C-124, Fairchild C-123, Martin Matador and Northrop Snark, and various helicopters. Scheduled is a demonstration of inflight fueling of a Boeing B-47 by a KC-97 tanker. French hope the B-52 will put in an appearance before the show is over.

Other foreign participation will include Fairey FD.2 speed record holder and perhaps English Electric P. 1; German Dornier 27, Italian Sagittario II jet fighter and Dutch Friendship airliner.

French Prototypes

French for the first time are displaying several new prototypes, including Dassault Etendard IV and Etendard VI, the latter being the company's entry in the NATO lightweight fighter competition contest which gets underway early in August. It is probable Dassault also will fly by its latest prototype, the delta wing Mirage III. Breguet is displaying for first time its turboprop Alize antisubmarine aircraft along with its new lightweight fighter prototype, 1100 (AW April 29, p. 31). Nord is showing its Gerfaut II prototype, which recently set rate of climb record, and its combination turbojet ramjet prototype, Griffon II.

New Powerplants

Sud Aviation's exhibition includes its delta wing interceptor prototype never before shown, the Durandal, and latest versions of its jet and rocket powered Trident II interceptor and tactical support fighter, Baroudeur.

Among the more interesting powerplant exhibitions are two low thrust French turbojets never before shown, Hispano Suiza R804 which develops about 3,300 lb. thrust and Dassault R7 which reportedly develops about 3,000 lb. Snecma piloted flying Atar VTOL also will be exhibited.

Last two days of show will be devoted mainly to aerial demonstrations, flybys and acrobatic displays. June 1 performance will be open only to guests of French Aircraft Industries Assn.

During the two day period, 60 different types of aircraft are slated to be flown.

FRENCH prototypes displayed publicly for the first time at the Paris Air Show include Sud Aviation's latest version of the Baroudeur, designated 5003. It differs from earlier versions in that it has Snecma Atar E engine replacing Atar D, larger ventral fins to increase stability, boundary layer separators. Baroudeur is an entry in NATO lightweight fighter competition, and in earlier military demonstration (which included flight by USAF Maj. Arthur Murray, a member of the Mutual Weapons Development Team), it flew over and identified target at low level and returned for attack in 27 sec., meeting NATO 30 sec. requirement.

FLIGHT photo of British SR. 53 rocket-jet interceptor shows dual tailpipes for Viper turbojet engine and Spectre rocket engine.

British Rocket Fighter Makes First Flight

London—Saunders Roe SR. 53 rocket-jet interceptor has made its first flight at the Boscombe Downs experimental station.

Single seat swept wing aircraft is powered by a de Havilland Spectre rocket engine and an Armstrong Siddeley Viper jet engine. The rocket motor is considered the main powerplant.

The Spectre is a liquid propellant rocket engine with variable thrust control.

Kerosene or gasoline is used as a fuel with high test hydrogen peroxide (HTP) as oxidant.

Nothing was disclosed on the rate of climb of the new aircraft, but a statement issued by de Havilland noted that rocket powered aircraft are able to climb to operational levels in the stratosphere "in a shorter time than has ever before been possible." It also mentioned very rapid acceleration to "high supersonic" combat speeds.

Although the French have been experimenting in this field for some time, this is the first British aircraft with a rocket as its main powerplant.

Saunders Roe noted that the mixed unit interceptor has a high degree of automatic control which will provide an important link between current fighters and the unmanned ground-to-air missile.

One great advantage of its performance at altitude is cited as the ability to accelerate rapidly through a tight turn. According to the firm, ratio of jet fuel to rocket fuel can be varied to meet extremes of interception needs.

Theory is that the jet will be used to gain range at optimum cruising altitude with the rocket being used for final climb and acceleration. Rocket and jet also can be used in combination for maximum climb.

Saunders Roe claims the mixed unit aircraft achieves low operational weight for required performance, the weight of the rocket engine with its fuel being lower than either additional jet engines or a larger jet engine.

The rocket powerplant also can be used to reduce takeoff runs to such an

FRONT view of SR. 53 reveals relatively small size of intakes. Viper is rated at 2,460 lb. thrust in its latest development.

extent that the company claims this type of aircraft will be able to operate from metal mesh laid on a meadow.

Despite the Ministry of Defense cutback on all supersonic fighters beyond the English Electric P. 1, military sources indicate that the experimental program with the SR. 53 will not be dropped. This could indicate possible future application of a mixed powerplant to the P. 1 as well as hope for an operational version of the Saunders Roe aircraft.

De Havilland's Spectre engine was developed under a Ministry of Supply contract.

It first ran in July, 1953, and made its first flight test in a Canberra in December of last year. Firm says flight testing proved out the advantage of its precise thrust control.

De Havilland's Gyron Junior engine has been designed to operate in high efficiency in connection with rocket power.

The firm suggests that its two powerplants offer a "logical partnership" for high performance military aircraft.

Test pilot on the initial flight was Squadron Leader J. S. Booth, chief test pilot of Saunders Roe. The aircraft was designed by a team led by M. J. Brennan, chief designer.

Erco Develops KC-135 Flight Simulator

STRATEGIC AIR COMMAND pilots begin a checkout in a KC-135 flight simulator designed and built by Erco Division, ACF Industries, Inc.

INSTRUCTOR creates problems for pilots at panel at right.

Riverdale, Md.—Flight simulator for the Boeing KC-135 jet tanker was delivered to the Air Force before the first aircraft was ready for operation, officials of Erco Division, ACF Industries, reported last week.

The Erco-designed simulator is the first of 11 units now on order. It already is in use at Castle AFB, Calif., where the Strategic Air Command established its first operational wing of Boeing B-52 long range jet bombers. Cost of the prototype is about $1.8 million, but average cost of the 11 simulators on order will run less than $500,000 each.

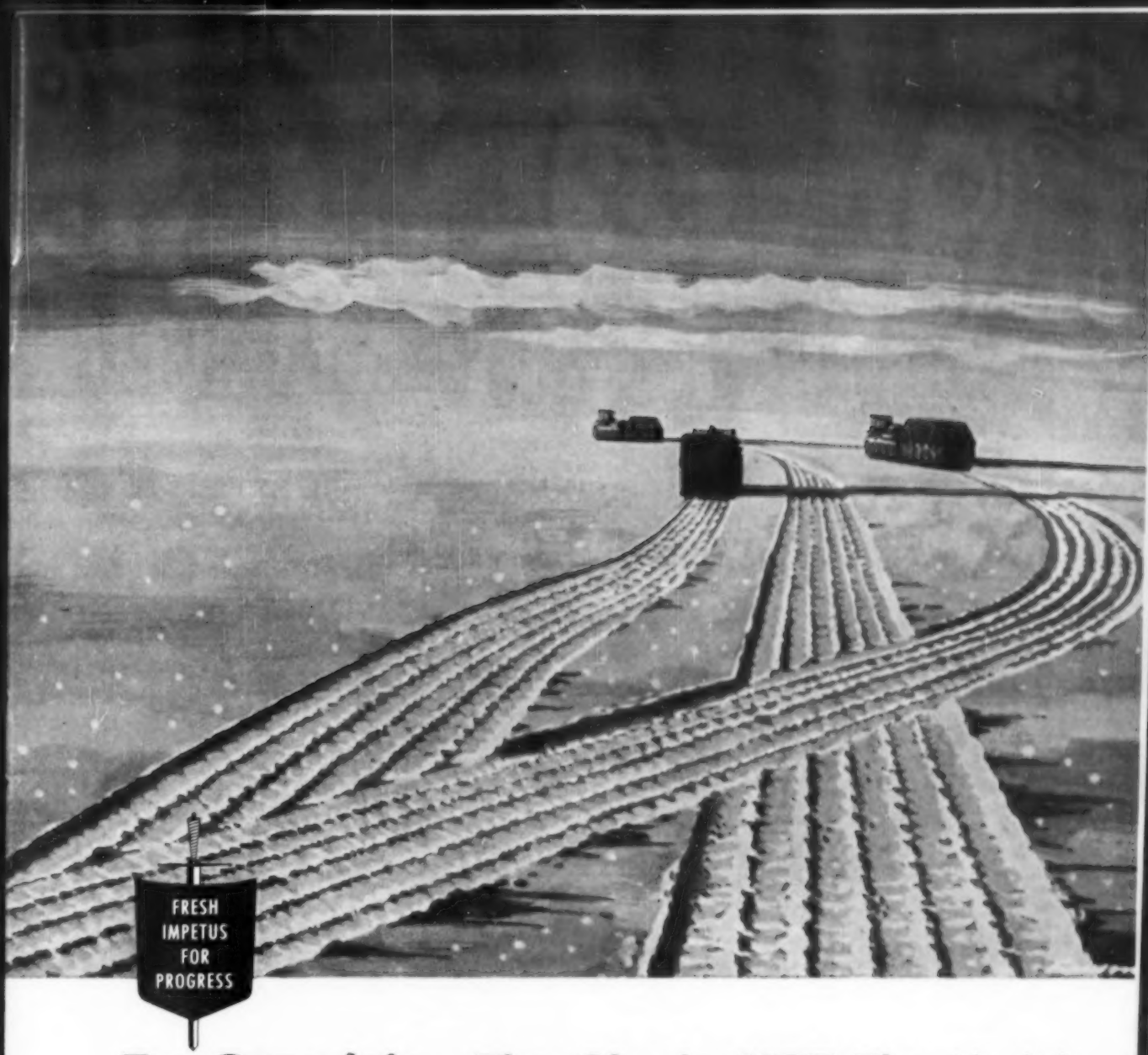
Erco spokesmen say they set a new record for fast development and delivery of the first unit, making it possible for SAC to obtain maximum benefit from the training device before the arrival of regular production versions of the KC-135.

The simulator incorporates latest configuration and performance characteristics of the jet tanker.

Program was speeded by these steps:

- **Erco and Boeing exchanged** engineering representatives to insure earliest possible transmission of accurate data, keeping the simulator up-to-date with engineering changes.
- **Monthly progress meetings** were held during development of the simulator. In addition to Boeing and Erco, the meetings included representatives of the KC-135 Weapon System Project Office, Wright Air Development Equipment Laboratory, Ogden Air Materiel Area and SAC.
- **Once the project was heavily under way,** Erco started a three-shift operation to speed construction. Test engineering worked two shifts daily on calibration of the equipment. Maintenance and incorporation of engineering changes was done on the third shift.
- **USAF acceptance test time** was cut from five weeks to two weeks. Boeing, SAC and WADC provided personnel to speed this part of the program.

The KC-135 simulator is one of the largest and most complicated training devices ever built. It has seats for two pilots with all controls and instruments



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CA57-05T-8

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duplicated as they are in the actual aircraft.

In addition to simulating ordinary flight regimes, it is capable of reproducing the changes in weight, flying characteristics and trim that take place during transfer of fuel from the tanker to bombers or fighters at high altitude. This makes it possible to practice actual refueling missions.

The manufacturer claims that the KC-135 simulator is the most complete training device ever built and that the specifications are the most rigid ever imposed on a designer. The machine is an analog computer, complete with radio, autopilot and refueling factors in addition to regular flight controls.

Convair Sees Trend To Avionics, Missiles

San Diego—Top official of Convair's San Diego Division, predicting that it will do an increasing amount and variety of avonics research and development for future air weapon systems, disclosed plans for a "substantial" expansion of the division's avionics staff and facilities.

Speaking before the West Coast Electronics Manufacturers Association (WCEMA) here, B. F. Coggan, vice president and manager of the San Diego operation, said that Convair's studies indicate that "the air defense mission will be performed largely by guided missiles in another decade."

In order to give Convair the capability for assuming full design and production responsibility for such weapons, Coggan said, San Diego must expand its avionics efforts. "To put it very bluntly, most of the system development and prototyping we will be doing is work that we cannot subcontract due to its integrated systems requirements," Coggan said.

"Much of this work is on the fringe of the present state of the art. Most of it requires frequent day-to-day collaboration and compromises between avionics engineers, aerodynamicists, physicists, nuclear physicists and others."

Pointing out that many of these programs involve risks which avionics manufacturers may be reluctant to take, Coggan said that "the fruits of these efforts, especially any one job, are at least uncertain when viewed in the light of production prospects. Taken in the aggregate, however, we feel that this activity is essential in maintaining Convair as a prime source of airpower 10 years from now."

Coggan said that Convair-San Diego would concentrate its avionics efforts largely in those fields which involve advanced types of air weapon systems. However, he earlier indicated that Convair's avionics activities had "proved so successful that we find ourselves doing jobs for many customers outside Convair." For example, Convair-San Diego is developing advanced types of airborne mapping radar systems under outside contract. Coggan also said that Convair now has "one of the best equipped and most technically competent radome design groups in the country."

Convair also expects to expand its avionics activities in the field of major assemblies, automatic check-out equipment and automatic process control, Coggan said.

Coggan emphasized that the company believes its "competitive position is strengthened by association with competent subcontractors." However he cautioned avionics manufacturers seeking Convair subcontracts on two points:

• **Specifications:** Convair has extremely rigid specifications to meet as a result of military weapon environmental and performance requirements and it expects all components provided by its suppliers to meet these same requirements. "Subcontractors who may feel that these requirements are just so much contractual boiler-plate, to be waived later in the interests of saving trouble or meeting schedules, are in for a rude surprise," Coggan warned.

• **Schedules:** Many different items must come together on time to enable Convair to meet its own delivery schedules, Coggan pointed out, and the military gives no relief from contract obligations when a Convair supplier is tardy.

"Therefore," Coggan said, "we continue to do business only with suppliers who do not fail us."

Coggan sees a growing avionics task ahead and says Convair will need outside assistance. As the avionics composition of Convair's air weapons grows, Convair expects to do more of this work inside the plant, but this will also mean more outside purchases from established manufacturers. Convair will be a good customer for components, test equipment and special purpose subsystems, Coggan said.

Profit Barrier Avionic Complaint

By Philip Klass

Dayton — Government must either grant a higher percentage profit to avionics and military electronics manufacturers or provide greater capital support if it is to maintain a healthy industry capable of meeting the increased demands of modern warfare.

This warning was sounded here by Dr. Ivan A. Getting, vice president of Raytheon Manufacturing Co., a major defense supplier, speaking at the recent National Conference on Aeronautical Electronics.

The electronic industry's TV business and profits have sagged badly so that nearly two-thirds of the industry's total business now comes directly or indirectly from defense business, Getting said.

Less Support

Getting complained that the government has not provided the electronics industry with the capital support which it gives to the aircraft and engine manufacturers. For example:

• **Facilities:** In the aircraft industry, government financing represents about 70% of the total plant investment, Getting said, based on a recent congressional report on aircraft costs and profits.

Although no electronics industry figure is available, Getting estimated that the ratio of Government to private investment was closer to 50/50.

• **Inventory:** Based on a study of five aircraft companies, Getting said that the government was financing 47-80% of the inventory through progress payments. In the electronics industry this figure is only about 30% Getting estimates.

As a result, Getting said, the overall return to stockholders on initial investment in the electronics industry is "substantially lower . . . than in the airframe industry. Under these conditions the industry can not attract private money to provide for increasing capital demands, nor is there any profit available with which to finance research and development for the military."

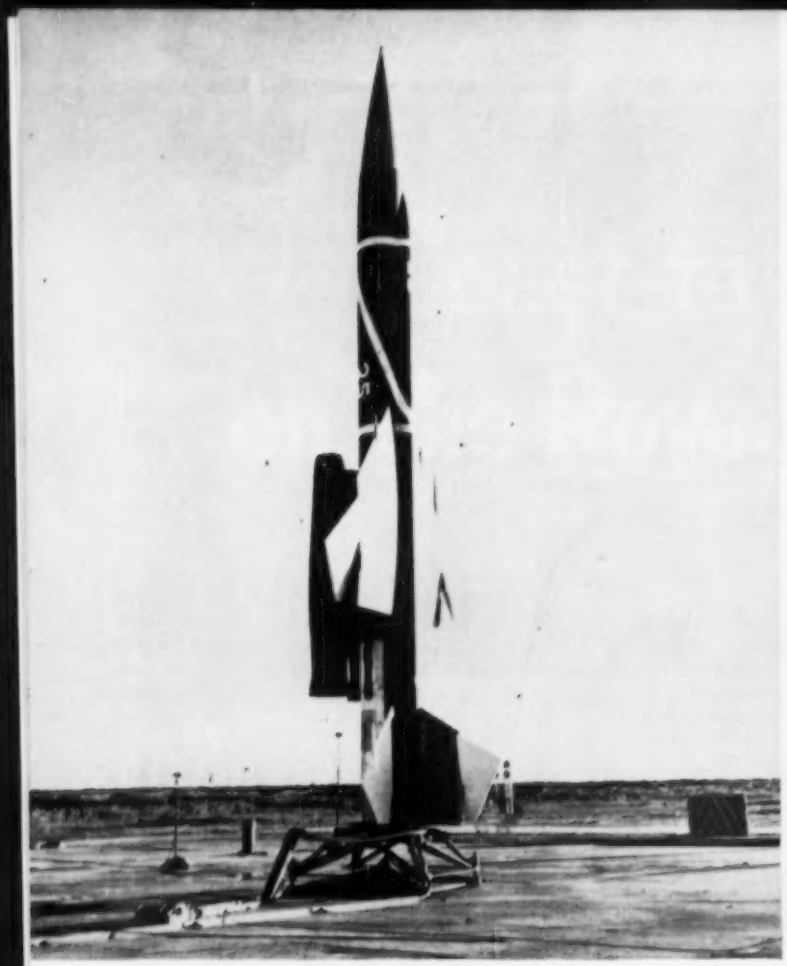
Better Fees

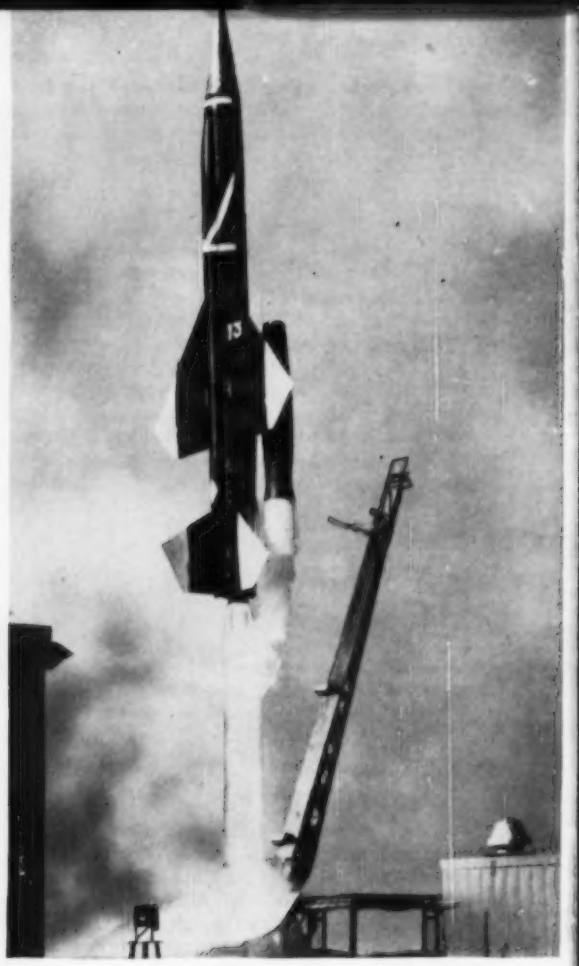
Getting said that companies that pour a large percentage of their engineering effort into Cost Plus Fixed Fee development programs should be given higher fees or "more considerate treatment of costs," where there is no production contract.

Getting was critical of the government for failing to invest in research and test facilities for electronics research on a basis comparable to its support of the National Advisory Committee for Aeronautics and the USAF's Arnold Engineering Center for aerodynamic and engine research. The electronics industry has equally difficult technological problems, Getting told the meeting.

One example:

"We are being asked to develop tubes which will dissipate upwards of 1,000 hp., comparable to an aircraft engine, but in volumes far smaller."





Ramjet Bomarc Has Tip Control Surfaces

TWO MARQUARDT 28 in. ramjets (AW Mar. 30, 1956, p. 48) power the Bomarc. Each unit weighs under 500 lb., produces roughly 50,000 hp. at Mach 2.5. Entire tips of the lifting and stabilizing surfaces deflect for control (upper left), aiding maneuverability.

FIRST PICTURES of the Boeing IM-99 Bomarc show the long-range area defense weapon on static display at Andrews AFB and during firing at Patrick Air Force Base, Florida. Boeing has been awarded a $7 million production contract for the missile after successful flight tests. Performance is in region of Mach 2.5, 200 mile range, and 60,000 ft. altitude. The Bomarc is directed to the vicinity of its target by ground radar, working through SAGE or similar computers and a ground-air data link. A self-contained guidance system, believed to be radar, then takes over to home in on the target. Bomarc's length is 47 ft., the span 18 ft. 2 in., and the weight about 15,000 lb.

EXHAUST nozzle of the liquid fuel launching rocket extends from fuselage (right). Rocket cuts out after ramjet starting velocity is reached. Note combination padlock on vertical tail surface (right). Guidance system was tested in modified B-57 (AW Jan. 14, p. 75).

Military Poses Threat to Civil Route Plan

Growing airspace areas reserved for the military draw airline fire, block jet airways proposals.

By L. L. Doty

Washington—Plans to establish 12 high-altitude transcontinental airways to handle non-stop jet transport operations by 1959 are being threatened by huge areas of uncharted military airspace that come to light only after civil routes are proposed.

AVIATION WEEK learned last week that the bitter wrangle for America's rapidly disappearing airspace has reached a critical "impasse" and that airlines now fear that the straight, through routes planned for jet operations may deteriorate into zigzag patterns if areas earmarked for military acrobatics and training are to be avoided.

One airline authority bluntly stated that the large sectors of airspace demanded by the Air Force are squeezing commercial operations into narrow corridors that snarl traffic and increase the threat of mid-air collisions. He added:

"These large military areas are vast roadblocks that are often uncharted training areas without any official designation. When we decide on an airway, then we are often informed by the military that such a routing competes with military operating sectors so we are forced to create detours."

Serious Airways Threats

Airlines point to these cases as currently the most serious threats to airways development and use:

• **Proposed gunnery training** area at Luke Field, Arizona, will overlay the Phoenix-Los Angeles airway and force civil aircraft taking off from Phoenix Sky Harbor Airport to reach an altitude of 4,500 ft. within eight miles of the runway threshhold to avoid military activities.

• **Move to establish airways** and controlled airspace through the Grand Canyon area is being blocked by 13,000 square miles of air-space requested by the Air Force for military operations. Two omni ranges were installed last April by the Civil Aeronautics Board before the military disclosed that the new airway would traverse the proposed military sector.

• **Continental Air Lines** has been blocked in attempts to obtain a direct airways with air traffic control protection between El Paso and Albuquerque to serve the intermediate point of Alamogordo, N. M., at Holloman AFB. The proposed airway borders a large area of restricted airspace, and the Air Force has warned that civil traffic on such an airway would conflict with military aircraft maneuvering outside the restricted area to achieve proper firing position.

• **An uncharted military sector** west of Kansas City, 300 miles in length and used for aerial refueling of jet aircraft, will cause a sharp bend in the major proposed New York-Los Angeles, high-altitude airways.

Inventory of Airspace

According to the Civil Aeronautics Administration, the chief source of the present dilemma has been a failure to take a full "inventory of airspace."

To correct this deficiency, the CAA—in cooperation with the military services—has instructed its air route traffic control center chiefs to conduct a survey of all military airspace within each center's region.

A CAA spokesman told AVIATION WEEK that the results of the survey indicate the amount of airspace held in reserve for military use has been "largely underestimated." He said the geographical findings have not yet been collated but that initial studies show the airspace problem has "reached a point where there is no longer any room for give or take."

He admitted that the Air Coordinating Committee has been helpful in resolving a number of conflicts and cited the some 2,500 cases on airspace handled last year. But he echoed the airlines' conviction that the problem now calls for action on a national level rather than on a local level. The Federal Aviation Agency, proposed by Presidential Assistant Edward Curtis, will provide the mechanism necessary to allocate airspace on a nation-wide basis (AW May 20, p. 26).

Air Transport Assn. agrees that the Curtis proposal may finally settle the issue but points out that the permanent program is three years away and that decisions must be made now if an adequate airways pattern is to be implemented. ATA questions the power of the proposed interim Airways Modernization Board to dictate airspace policy on the scale visualized by Curtis.

A Pentagon spokesman said military authorities also are looking to the proposed Federal Aviation Agency as ultimate mediator in airspace allocation.

He said the Air Force is not fighting the CAA but is trying to assist the CAA in establishing required airways. However, he added that USAF is faced with the "question of how we are going to accommodate essential military activity."

He explained that the military problem has been intensified recently by the CAA's six year federal airways plan which, he said, is being implemented on a "crash basis" and "any crash program will inevitably run into other existing programs."

Both the airlines and the CAA emphasize that the airspace problem is not a "battle" between civil and military agencies. A CAA spokesman explained it this way—the problem resolves itself into a conflict between "a common airways system and special military requirements."

However, local hassles between military commands and the airlines sometimes spiral upward to top level authorities to intensify airspace conflicts. The Luke Field controversy came to light when the Air Force advised the Air Transport Assn. that it "is impossible to conduct jet operations from that base (Luke) to existing gunnery ranges without crossing heavily traveled federal airways."

The Air Force warned that in spite of precautions taken by the local Air Force commander by funneling jet aircraft over check points and by urging students to exercise caution when penetrating the airways, "the probability of mid-air collision is high."

USAF told ATA that the airlines operating through Phoenix have been unwilling to accept the "reasonable compromise proposal" that air carriers maintain 4,500 ft. or higher at the jet penetration points and added:

"This headquarters fails to understand the position taken by the air carriers. . . . The precautionary measures taken by the Air Force will not suffice without the full cooperation of the air carriers operating in the Phoenix area."

The Air Force said steps had been taken toward establishing caution areas to encompass the jet training area, exit and entry corridors and a "reasonable floor on the airways segment involved."

ATA, however, contends that the proposal would require airliners taking off to reach the floor level of 4,500 ft.

within eight miles of the Phoenix commercial airport.

ATA countered the Air Force charges by stating that "We have been unable to find any evidence that the Air Force furnished details or even generalities in regard to the problem at Luke, prior to the meeting at Luke Field Air Force Base on Jan. 17, 1957, at which time our representative on the West Coast was informed by your liaison officer that there 'was a problem at Luke.'"

At a later meeting of the two groups, ATA said it received the Air Force proposal which would block "the use of one of the busiest federal airways under VFR conditions up to 5,000 ft." It added that details and charts requested from the Air Force to assist in coordinating the problems with the airlines involved "have not been made available to us."

The association said the air carriers offered an alternate proposal to the Air Force at the meeting which "in our estimation, would be more equitable to all users." At that time, the ATA continued, there was no USAF suggestion of a proposed caution area and the first notification that the airways would be blocked came with a published announcement in the Airman's Guide of March 19.

ATA said it can "only conclude that you have construed a lack of cooperation purely on the basis of non-acceptance of your proposal" and added:

"We appreciate the fact that there is a serious problem created entirely through the operation of aircraft from the Luke Field Air Force Base. Rather than continue this problem which the Air Force has created, it would be more equitable that this type of Air Force operation be eliminated, pending a solution of the problem."

Grand Canyon Debate

In the Grand Canyon area, two omni ranges were installed in April as a first step toward controlling the airways through the sector. However, the airway link between the VORs at Valle and Farmington now crosses the upper portion of a proposed military airspace reservation while a second airway running in a southeasterly direction from Valle, Arizona, to Roswell, N. M., cuts off a large slice of the lower portion of the reserved area.

The proposed sector will encompass seven small civil airports and cover an area equivalent to the square miles contained in the states of Rhode Island, New Jersey and Connecticut. The situation was unknown to the CAA at the time the VORs were installed.

Continental Air Lines operates north-south flights between El Paso and Albuquerque, serving Alamogordo through Holloman Air Force Base as an intermediate scheduled stop.

Direct flights along the route would necessitate following the east border of a large area of airspace used for training by Holloman. At present, Continental flights operate off-airways under VFR flight conditions over a devious route to avoid the area and serve Holloman. A request that a direct airways be established brought this response from the Air Force:

An airways near the reserved airspace sector is impractical because flights may encounter balloons and parachutes drifting eastward, missiles with active homing systems which can link on aircraft, drone aircraft, night missiles and high-performance aircraft operating outside the restricted area.

A Continental official told AVIATION WEEK, "The Air Force is forcing us to provide a second-class type of service to an area that requires first-class service."

Other airspace differences drawing fire from the airlines include the high-density sector surrounding Los Angeles, off-shore airways between Milwaukee and Chicago and the overwater segment of the New York-Florida route that is confined to a narrow corridor because of Navy activities.

Although the airline industry is negotiating each of the conflicts as it appears, most authorities agree with Curtis that the granting of airspace on a "case-by-case basis" must be replaced with a "clear national policy regarding the use of airspace by two or more agencies."

BOAC Will Order 35 Vickers Turbojets

London—British Overseas Airways Corp. will order 35 Vickers medium-range jet airliners, dampening prospects for two other British civil jet design proposals.

BOAC's order for the new four-jet Vickers VC-10 is valued at $190 million including initial spares. Plane will be developed by Vickers Armstrongs as a private venture with no government funds.

The decision dims hopes for de Havilland's Comet 4B, a bigger, more economical model the company announced only last week. It also hurt chances for Handley Page's recently announced design for a civil version of the Victor jet bomber.

Still another jet contender, a Bristol Aeroplane Co. design, is believed to be the choice of British European Airways for a relatively small order.

The VC-10 normally will seat up to 120 passengers. It will be powered by four Rolls-Royce Conway engines mounted at the rear of the fuselage in a manner similar to the French Caravelle (AW Sept. 24, p. 47).

BOAC plans to use the new Vickers jet on its African, Far Eastern and Australian routes. It is designed to be at its most efficient in stage lengths beyond 1,500 mi. The Vickers plane will have a double bubble fuselage similar to the Vickers Vanguard, carrying passengers on the upper deck and cargo in the hold. Vickers says that in its highest density version the VC-10 will carry up to 147 passengers.

Plane is designed for good field performance at high altitude airfields and under high temperature conditions. Cruising speed is expected to exceed 600 mph.

The British government has approved the capital expenditure by BOAC, which is state owned. British jet airliner situation has come full circle through a number of proposals back to Vickers which had the V-1000 jet airliner prototype well under construction when the government contract was canceled in late 1955.

Vickers, which has sold almost 400 turboprop Viscounts and is building forty large turboprop Vanguards for British European Airways and Trans Canada Airlines, thus becomes the only company on either side of the Atlantic so strongly entrenched in both turboprop and turbojet aircraft fields.

Vanguard deliveries to both operators are scheduled to begin in 1960. Deliveries of the new jet airliner will begin in 1963. The company believes there are large markets for both types.

"The worldwide advantages of a jet aircraft of this type with especially good takeoff characteristics will, we believe, make the Vickers VC-10 a strong competitor with the U. S. jets in the same class," according to Sir George Edwards, managing director of Vickers Armstrongs Aircraft Ltd.

BOAC says the order will be placed as soon as the preparatory work of drawing up the contract and detailed specifications is completed. In addition to 33 Bristol Britannias, BOAC now has on order 19 de Havilland Comet 4s and 15 Boeing 707s.

Decision in favor of the Vickers aircraft comes as somewhat of a surprise for two reasons. One, it cuts off any possibility of a follow-on BOAC order for Comets. Two, it puts a definite end to past government policy of sharing available orders among the major British manufacturers. Apparently, the decision was made on technical merit in

Airline Traffic—First Quarter 1957

	Revenue Passengers	Revenue Passenger Miles (000)	Load Factor Per Cent	U. S. Mail	Express	Freight	Total Revenue Ton-Miles	Per Cent Revenue to Available Ton-Miles
DOMESTIC TRUNK								
American	1,710,789	1,143,209	62 8	5,008,127	2,519,033	19,189,157	136,455,258	57 7
Braniff	469,328	198,185	58 2	734,003	380,578	902,180	21,021,266	46 6
Capitol	765,603	308,557	57 0	982,439	519,013	708,109	31,731,978	45 9
Continental	178,321	65,851	54 5	214,276	69,393	296,956	6,906,129	45 9
Delta	644,304	332,561	59 8	1,045,128	896,791	1,699,464	35,563,170	54 9
Eastern	1,921,499	1,206,517	60 2	2,800,107	1,302,074	2,931,818	123,386,954	43 9
National	433,818	311,937	62 6	1,005,925	206,943	1,476,380	33,331,192	52 4
Northeast	119,754	29,929	44 3	38,049	47,127	108,783	3,058,894	40 1
Northwest	276,442	182,036	52 8	1,082,363	645,676	1,958,745	21,170,085	46 7
Trans-World	960,186	772,315	58 4	3,084,218	2,211,373	5,881,114	81,353,215	52 8
United	1,366,131	962,227	61 0	6,790,470	2,843,715	11,744,364	113,466,200	53 7
Western	307,467	157,147	63 1	720,725	280,508	565,209	15,914,362	58 6
INTERNATIONAL								
American	37,102	29,520	71 1	35,032	1,247	664,622	4,094,434	73 9
Braniff	8,905	18,685	51 1	73,056	.....	214,640	2,366,945	55 6
Caribbean-Atlantic	63,081	4,550	55 2	4,092	.....	11,133	489,048	57 5
Delta	17,090	18,924	61 3	20,209	.....	175,571	2,290,727	60 4
Eastern	67,273	89,848	69 2	241,274	.....	242,873	9,848,395	56 7
National	27,239	17,917	55 4	29,091	14,171	187,267	2,007,071	54 6
Northwest	23,669	52,749	50 5	2,857,242	62,843	1,864,631	10,379,430	62 4
Pan American								
Alaska	11,978	13,575	44 9	96,070	.....	467,027	1,990,306	42 5
Atlantic	186,294	262,451	59 0	3,384,246	.....	3,943,027	35,000,710	59 6
Latin America	313,577	288,211	63 9	1,158,406	.....	10,926,491	40,480,903	65 1
Pacific**	62,962	240,291	72 7	2,893,256	.....	4,106,664	28,446,631	66 7
Panagra	34,833	45,555	63 5	176,981	.....	950,940	6,004,020	62 7
Trans-World	41,551	111,912	58 4	2,253,424	.....	1,879,792	15,684,753	65 9
United	19,449	48,994	61 2	243,120	.....	189,517	5,459,472	55 7
LOCAL SERVICE								
Allegheny	74,181	14,834	39 8	22,666	52,583	25,816	1,477,305	40 2
Bonanza	34,518	8,274	47 5	13,543	6,586	16,985	771,171	45 7
Central*	.....	.....	.....	.....	.....	.....	.....	.....
Frontier	46,347	14,092	45 3	56,996	20,718	154,460	1,465,374	54 1
Lake Central	33,480	5,380	42 3	7,223	33,659	.....	532,107	39 5
Mohawk*	.....	.....	.....	.....	.....	.....	.....	.....
North Central	141,827	22,553	45 8	57,854	84,732	4,363	2,149,319	46 7
Ozark	77,571	12,065	36 9	29,685	45,632	16,908	1,252,595	41 7
Piedmont	78,905	17,053	47 5	34,504	29,520	30,613	1,632,779	47 3
Southern	47,852	8,950	44 1	25,892	28,152	2,113	855,565	41 7
Southwest	69,937	15,155	49 5	26,028	13,001	21,347	1,450,095	48 0
Trans-Texas	56,446	12,824	38 7	40,181	24,008	61,887	1,348,749	36 2
West Coast	51,956	9,353	43 2	12,152	5,774	11,575	913,997	42 0
HAWAIIAN								
Hawaiian	88,648	13,666	48 9	11,384	.....	301,398	1,444,606	55 8
Trans-Pacific*	.....	.....	.....	.....	.....	.....	.....	.....
CARGO LINES								
Aerovias Sud-Americana	.....	.....	.....	.....	.....	2,096,429	2,037,821	81 8
Flying Tiger	17,306	71,699	99 4	125,970	104,120	12,471,268	22,690,630	80 2
Riddle*	.....	.....	.....	.....	.....	.....	.....	.....
Seaboard-Western	2,284	14,162	100 0	.....	.....	3,860,034	2,994,791	65 4
Slick	14,443	55,196	93 5	233,992	252,710	13,970,832	13,320,540	71 2
HELICOPTER								
Chicago Helicopter	3,941	63	32 1	7,263 5	.....	.....	13,314 5	39 2
Los Angeles Airways	6,713	243	43 8	10,799	6,111	.....	40,617	55 6
New York Airways	11,951	225	33 0	**3,908	2,794	1,629	29,804	38 7
ALASKAN								
Alaska Airlines	4,341	1,741	23 4	57,867	.....	437,771	650,031	39 1
Alaska Coastal	8,041	732	60 8	10,498	.....	8,209	88,661	63 4
Cordova	3,033	690	44 8	8,587	.....	110,666	62,059	46 6
Ellis	7,966	559	52 7	4,500	.....	6,243	64,491	67 2
Pacific-Northern	11,174	15,638	40 7	91,527	.....	491,965	1,721,384	51 7

*Not available.
**Mail transferred in bulk.
Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board.

spite of the fact that Vickers already is quite busy with Viscount and Vanguard orders.

This marks a swift reversal from a few months ago when the government announced de Havilland would build the DH-118 jet airliner for BOAC. This purely political announcement was a jolt both to the airline, which didn't want the aircraft, and the manufacturer, which was not very interested in building it. Eventually the project was dropped.

The technical decision in favor of the Vickers aircraft—which apparently only a political decision similar to the DH-118 fiasco could upset at this point—was made after a design competition which a number of British manufacturers entered.

In two separate competitions, BOAC sought a medium to long range jet and BEA sought a short to medium jet. BOAC entrants included Vickers, de Havilland, Handley Page and possibly Bristol. Designs were submitted to BEA by Vickers, Bristol and de Havilland.

The Comet 4B and Vickers VC-10 could still be possibilities for BEA in view of the fact that its order may be too small to warrant production of the Bristol jet, which also is believed to have four engines mounted aft on the fuselage.

Number of jets required by BEA is said to be as low as six.

The announcement of de Havilland Aircraft's new project followed Capital Airlines' decision to at least temporarily shelve its order for four Comets 4s and 10 Comet 4As (AW May 13, p. 39).

De Havilland said the new Comet 4B will offer a medium range jet with a 10% increase in seating capacity and a 15% reduction in seat-mile cost, factors which will enable the jet to operate on an economical level of a turboprop airliner.

Fuselage of the new Comet will be extended 38 inches over that of the Comet 4A to allow for two extra rows of passenger seats.

Removal of the wing nacelle tanks is also planned.

No change has been made in the gross weight of 152,500 lb. The new aircraft will carry 99 passengers in a tourist version; 84 first class.

De Havilland gave these alternative methods of cruising the aircraft:

For maximum speed over short stages, it can be flown at an optimum altitude of 23,500 ft. at speeds between 520 mph. and 545 mph. carrying a payload of 20,000 lb. over 300-2,000 mi. stages.

It also can be climbed to 38,000-42,000 ft. at a cruising speed of 490 to 500 mph. to extend the stage length to 2,600 mi. with the same payload.

By comparison, the intercontinental Comet 4 under construction for British Overseas Airways Corp. will have a stage length of 3,000 mi. with a capacity payload of 14,500 lb.

De Havilland said that with first-class seating, seat-mile cost of the 4B will vary from 1.6 cents per seat-mile on longer stages to about two cents on a 500-mile stage.

Break-even passengers load factor for the Comet 4B on a representative 750 mi. stage is given as 37%. On a 300 mi. stage, the aircraft is designed to have a 50% break-even load factor.

The 4B, to be known as the Continental Comet, will have the same quick turn-around features planned for the 4A. These will include integral power-operated passenger stairs and a built-in auxiliary power starter. Provision is also made for ground refrigeration.

Both de Havilland and Vickers have indicated their intention to continue work on aircraft ordered by Capital despite the airline's shelving decision which involved 14 Comets and 15 Vickers Viscounts.

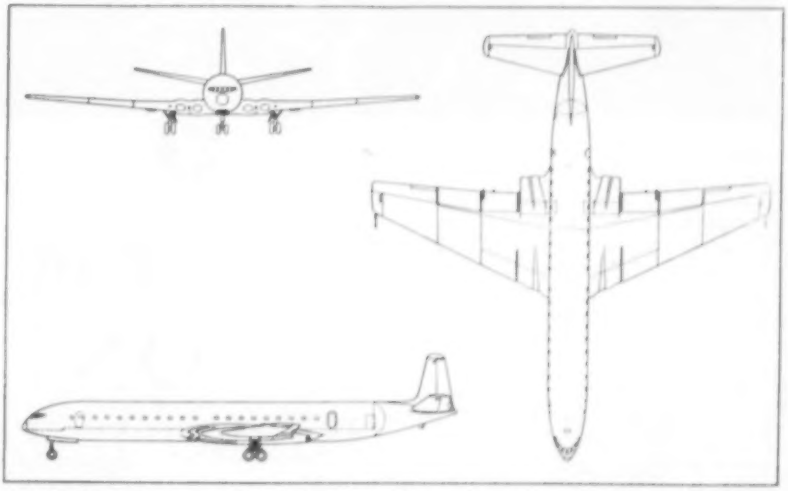
De Havilland is hopeful that Capital will renew the order later this year.

If the airline should renew its order, it now presumably would be for 4Bs.

Vickers expects no trouble in disposing of its aircraft elsewhere if the Capital order is not renewed.

Civil version of Britain's four-jet long

CIVIL VICTOR proposed by Handley Page is version of Britain's four-jet bomber. Four Rolls-Royce Conway engines will power the plane, give it a 600 mph. cruising speed, manufacturer says. Civil Victor could carry 172 passengers London-Rome non-stop.



COMET 4B features extended fuselage 38 in. longer than 4A to allow for two extra rows of seats. Passenger capacity of the new model is 99 tourist or 84 first class. Seat total is 10% greater, seat-mile cost 15% less, according to de Havilland. Gross weight remains at 152,500 lb. Wing nacelle tanks have been removed.

SUD-AVIATION

CARAVELLE

ROLLS-ROYCE
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TURBO JETS

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range Victor bomber could carry 172 passengers London-Rome at a cruising speed of 600 mph. or better.

Increased tankage, according to Handley Page, would permit New York-London non-stop operation with 122 passengers.

Rolls-Royce Conway engines are planned as the civil Victor's powerplant and they would be equipped with silencers and thrust reversers. Four-man crew includes two pilots, navigator and radio operator.

Operation from existing airfields, without need of runway extensions, is cited as a major Victor advantage. The airplane will use a maximum of 6,120 ft. for takeoff at its top all-up gross of 214,000 lb., and a maximum of 4,230 ft. for landing at 160,000 lb.

Wings and tail of the proposed civil aircraft are same as those of the Victor bomber.

Similarity also applies to flying controls, systems and services.

Fuselage, however, is new, and is of double-deck design. Two of three passenger entry doors are located on the upper deck, the third on the lower deck. Baggage door is on the upper deck, freight door at rear of lower deck. Galley is below. Decks are connected by two spiral staircases.

Typical internal layout, according

Victor Transport Specifications

Engines	4 Rolls-Royce Conway
Wing Span	126 ft.
Overall Length	126 ft. 3 in.
Overall Height	33 ft.
Fuselage Length	112 ft.
External Fuselage Width	12 ft.
Total Fuselage Volume	11,250 cu. ft.
Usable Fuselage Volume	9,850 cu. ft.
Freight and Baggage Volume	860 cu. ft.
Max. Passenger Seats, 34 in. pitch	172
Fuel in Wing Tanks	8,000 I. gal.
Fuel in Tip-Tanks	2,600 I. gal.
Total Usable Fuel	10,500 I. gal.
Total Usable Fuel (Long-Range Version)	12,000 I. gal.
Maximum Take-Off Weight	214,000 lb.
Maximum Landing Weight	160,000 lb.
Maximum Payload	40,000 lb.
Gross Distance to 50 ft. at 214,000 lb. Gross Weight	1,720 yd.
Balanced Field Length for Take-Off, 214,000 lb. All-Up Weight	2,040 yd.
Landing Distance From 50 ft. at 160,000 lb. Gross Weight	1,410 yd.
Approach Speed at Maximum Landing Weight	154 mph.
Touchdown Speed at Maximum Landing Weight	136 mph.
Rate of Climb at 30,000 ft. (at 214,000 lb.)	2,500 ft./min.
Time to 30,000 ft.	8 min.
Cruising Speed at 40,000 ft.	over 600 mph.

AIRLINE OBSERVER

► Look for Capital Airlines to choose the twin-engine Sud Caravelle jet transport to replace its suspended order for 14 de Havilland Comets (AW July 30, p. 40). A large number of Capital's top engineers and management staff attended each of the Caravelle's demonstration flights during its recent tour on the East Coast. The airline originally bypassed the French transport because of a strong leaning toward four-engine equipment. Now, Capital feels that the low operating costs and passenger appeal of the Caravelle will offset any disadvantages stemming from the aircraft's two-engine configuration.

► Wall Street observers feel that Capital's suspension of the Comets and 15 additional Vickers Viscount turboprop purchases is providing a breathing spell for Capital Airlines that will permit revenues to catch up with expenses for the first time since the delivery of the Viscounts began. Capital already has 59 Viscounts on hand. During the past 18 months, pre-staffing, training and other expansion expenses have consistently out-stripped revenue increases. Substantial improvement in operating results during the first quarter of the year, coupled with a recent leveling off of expenses, has resulted in a normal relationship between costs and revenues that will set the stage for a revised equipment program.

► Abolition of visas and acceptance of identity cards or expired passports for inter-European trips of short duration has been proposed by the European Civil Aviation Council. The recommendation, designed to encourage European air travel, also includes exemption of children from government documentary requirements, simplified clearance of baggage and the elimination of passenger manifests. The group also called for more adequate hotel facilities in Europe to prepare for the jet age of air transportation.

► Douglas Aircraft has cut engineering overtime on all commercial transport production including the DC-8 jet transport. The move followed the reduction of overtime on all military projects except Douglas' Thor intermediate range ballistic missile (AW May 6, p. 29). Engineers working on DC-6 and DC-7 series projects have been reduced to a 40 hour week and direct engineering hours per week on the DC-8 have been cut to 40 hours and 48 hours in alternate weeks. Rate still runs higher for groups lagging behind schedule.

► Air Transport Assn. proposed reconfirmation ruling and $3 penalty plan against no-shows has been presented to the Civil Aeronautics Board. If approved by the board the reconfirmation requirement will be effective July 14 and the penalty plan September 15.

► Air Line Pilots Assn. membership has voted unanimously for adoption of a proposal that would require IFR flights on triangle airways between Washington, New York and Chicago above 9,500 ft. (AW May 6, p. 40). If airlines also approve the proposal, the plan is scheduled to go into effect on July 1.

► American Airlines is contending that a permit granted it by the Mexican government to operate between Mexico City and Dallas-Fort Worth cannot be revoked, suspended or cancelled under Mexican law except for failure to provide service. The point was raised by American Airlines attorney Erby Swift during Civil Aeronautics Board hearings on the Chicago-Mexico City case.

► Aeroflot, Soviet-owned airline, claims successful use of fog-dispersing techniques for Tu-104 jet transport operations. The airline described the operation of an Li-2 piston-engine transport equipped with fog-dispersal apparatus over a fog-shrouded river and airport at Irtutsk. While an eastbound Tu-104 stood by waiting to land, the Li-2 flew through the area ejecting a "stream of white flakes—dry ice—into the air" to open a fog-free corridor for the jet transport by causing droplets of moisture to change into snowflakes.

Aviation Memo:

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and it's the only fastener that will meet your future requirements, too.

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to Handley Page, is a mixed configuration with 20 first class, 117 tourist seats. Bunks for first class passengers, toilets and dressing rooms on both decks, a service lift between the decks, and a lounge and bar are features of layout.

Manufacturer says the civil Victor could be operated between London and Johannesburg with one stop—at Kano in Nigeria—on the 5,728-mi. route. Flying time would be 11 hr. 21 min.

The Victor can enter service as a commercial airliner in 1961, Handley Page says.

Cancelled Viscount To Make U. S. Tour

London—Vickers-Armstrong has dispatched one of the turboprop Viscount airliners originally ordered by Capital Airlines on a U.S. sales tour under company colors. The move is part of an effort to find buyers for the 15 Viscounts made available when Capital decided not to buy them.

Since six of the aircraft now are flying and the remainder are in an advanced stage of construction, the company does not anticipate any great difficulty in finding buyers who are seeking early delivery.

Vickers-Armstrong would prefer to have the dollars which U. S. sales would bring and is making its initial pitch there. Results are said to be "very encouraging." A number of airlines have expressed interest.

Wing Flap Error Blamed in DC-6 Crash

Washington—Full retraction of wing flaps at low altitude during a circling approach to the airport without necessary corrective action was listed by the Civil Aeronautics Board last week as the probable cause of a Canadian Pacific Airlines DC-6B crash at Cold Bay, Alaska, last August.

Eleven passengers and four crew members were killed in the accident; another three passengers were injured. At the time of the crash, the aircraft was en route from Vancouver to Tokyo and Hong Kong.

Investigation disclosed that the aircraft was approaching the airport and, after breaking through overcast, the pilot may have found he was not in position to land on the runway and decided to go around. The plane settled and crashed as a turn was being executed.

The CAB also said that in addition to the retracted flaps, it also was determined that the engines were not operating at the prescribed power settings necessary to execute a missed-approach procedure.

Silencing Jet Fleet Will Be Costly, Civil Engineers Are Advised

New York—Airline use of sound suppressors on their fleets of jet transports is not going to come cheap, an American Airlines official told American Society of Civil Engineers members at a recent jet-age conference held here under sponsorship of ASCE's Air Transport Division.

Cost of quieting American's 30-plane Boeing 707 fleet will approximate $50 million over the operational life of the fleet, according to Marvin Whitlock, vice-president, operations planning. Factors contributing to the high cost, Whitlock said, include:

- 6% **increase** in takeoff runway length.
- 2% **boost** in fuel consumption.
- **Thrust loss** of 1½-2%.
- **Aircraft weight** increase of about 400 lb.

Basis of American's calculations was a derated Pratt and Whitney J57, which was scaled up to a full-thrust J57, Whitlock said. Current indication, he added, is that noise level of the J57, J75 and Rolls-Royce Conway are about the same.

Whitlock said the cost would have to be passed along to the paying passengers.

Engineers attending the session on problems they will be facing with the new transports heard an optimistic report from Boeing Airplane Co. on its noise suppressor work.

Suppressor Answer

Donald A. Buck, Boeing's manager of transport operations planning, told the meeting that, in regard to jet engine noise suppressors, "We think we have the complete answer . . . by this summer, our prototype 707 will be fitted with four sound suppressor devices that we consider to be the prototype models of production units. . . . With the use of such effective suppressors and the best climbout procedures for each locality, civil jet transports are not expected to be any noisier—or even as noisy—as some of today's airliners."

Buck made these observations about jet sound suppressors:

- **Characteristic** of sound is that the higher frequencies are rapidly attenuated with distance. This characteristic is used to advantage in current suppressor designs which attenuate low and medium frequencies of the jet exhaust by the greatest amount.
- **With some models** of suppressors, it has been possible to reduce sound pressure level by as much as 40 decibels at some frequencies.
- **Suppressor drag** ranges from 6%-7% at cruising speed.
- **Suppressors induce** a thrust loss of about 1½%-2% and a weight penalty of approximately 100 lb. per unit.
- **Taxi procedures** using additional engines to reduce required thrust on each engine cut noise levels, Boeing found. When turning maneuvers were accomplished with two engines on one side of the plane instead of one engine, sound was reduced by 6 to 8 decibels. Straight taxi with all four engines instead of two resulted in a 2 to 3 decibel reduction.
- **From idle to 83%** rpm. is the range of power involved in terminal operations. At 63% rpm. during idle, sound level is about 95 db with the 707; when the pilot applies power to start his taxi roll, rpm. rises to 83%, sound goes up to 103-104 db, as taxi roll is under way, engine power is cut back and noise drops to idle level.

Terminal Mockup

Buck described tests conducted in a mockup terminal area Boeing built at Seattle. Concrete block finger-type mockup was 80 ft. long, 15 ft. deep, 9½ ft. high. Tests covered 14 different operations with the 707 prototype and a KC-97 tanker. The jet transport's noise outside gates of the terminal was 110 db and 113 db during some tests, while noise inside the finger at same power level was only 92 db and 91 db. Keeping passengers in a terminal finger, along with use of fences, will effectively dispose of the noise problems at gates, Boeing feels.

Proper location of takeoff areas can eliminate 40-50 db of takeoff noise at the terminal, he noted.

With the use of suppressor/reverser on commercial jet transports, Buck said, relative runway lengths will be 500 ft. greater.

By the time production 707s are equipped with the suppressor/reverser devices, Boeing will have spent $20 million on their development, according to Buck.

Buck commented that tests with the 707 prototype indicate that blast and deflector fences effectively cut blast and noise respectively and will remove any problems of taxiing, loading passengers, and ground servicing of jets at airport terminals.

Other Boeing comments:

Company believes that, as number of passengers increase and available air space decreases, the number of passengers per plane will have to rise. Engine power improvements will take care of corresponding increases in takeoff weight and longer runways will not be

MORE ABOUT BRISTOL'S "WHISPERING GIANT"

Noise-level tests prove that

World's largest, fastest, quietest turboprop airliner reduces noise levels to a new low

Official noise-level tests at a large international airport have underlined the amazing quietness of Bristol's Whispering Giant. With a ground noise-level of 81 decibels when taking off, the Britannia was 50 decibels quieter than jet transports flying today, 20-25 decibels quieter than current four-engined airliners . . . and quieter even than twin-engined airliners.

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She is the latest product of a company long renowned for progressive ability, achievement and reliability in aviation techniques.

The Britannia has met with worldwide recognition and demand. She is now in commercial service with British Overseas Airways Corporation and has also been ordered by Northeast Airlines, Canadian Pacific Airlines, El Al Israel Airlines, Hunting-Clan Air Transport, The Royal Air Force and The British Ministry of Supply.

BRISTOL

Britannia

BRISTOL AIRCRAFT LIMITED • ENGLAND

needed for takeoff. However, since the enlarged planes will also be heavier at landing, longer landing requirements are probable.

Boeing studies show that turbojets, rather than turboprops, will be the future short-haul aircraft. Company says it is possible to build a small jet plane that will operate economically at ranges of 500 miles and less and will require takeoff runway lengths of 4,800 ft. Such planes will have about the same cost patterns at today's short haul aircraft.

Since the 707's outboard engines are 92 ft. apart, it will be advisable to surface areas on either side of taxiways these planes will use to prevent airport erosion and engine ingestion of debris. As long as these new surfaces are plainly marked, they can be of thin section since they will not have to carry any appreciable loads.

This is a program that can start immediately, Boeing says.

Douglas DC-8

James B. Edwards, Assistant to the Chief Engineer, Douglas Aircraft Co., stressed pilot training for jet transports. According to Edwards, "Pilot training is a very necessary thing to the safety and proper operational use of today's complex aircraft. The hazards of training in flight affect the manufacturer, the operator, and the airport community.

"To reduce this type of flying to a minimum, a DC-8 simulator is being built to our specifications by Link Aviation and will be in service prior to our first airplane flight.

"Having a simulator in operation before a plane's first flight is an innovation in the air transport business, and will permit our engineers and pilots not only to study systems operations completely, but will also help to establish desired control forces.

"Another connected development is the Douglas-designed Telerama runway simulator. This device permits a pilot to perform airport checkouts since airport relief maps used with the device may be made to duplicate exactly any desired landing field."

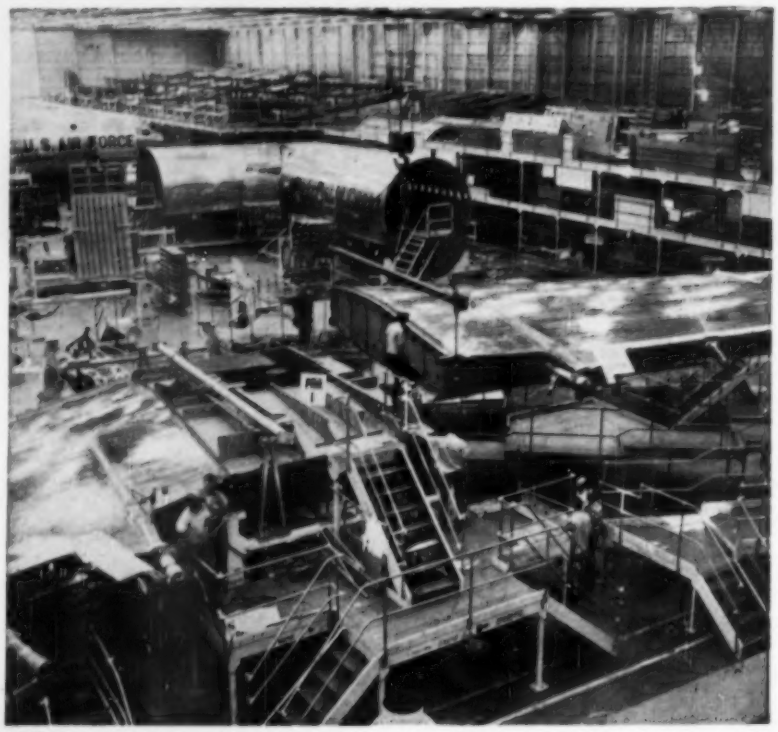
Other Points

Other points made by Edwards:

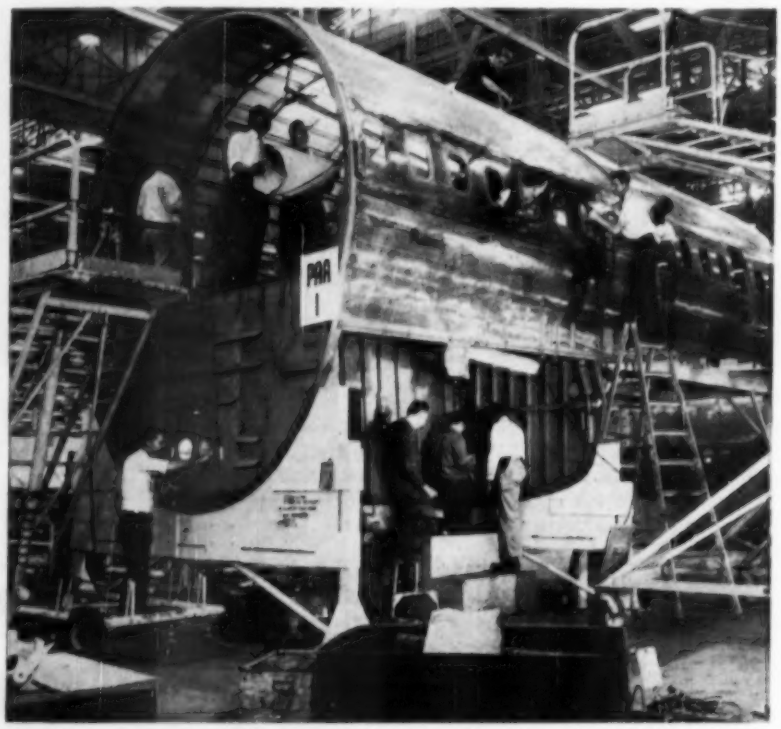
• **Approach and landing** speeds of the DC-8 will approximate current large transport aircraft. He cited these typical figures: downwind leg—155 kt.; base leg—140 kt.; final approach—128 kt.; touchdown—118 kt.

• **Tight turns** on the ground can be made with the DC-8 in spite of its four-wheel, bogie main landing gear configuration. Reason is that the rear pair of wheels caster freely when the nose wheel is turned more than 45 deg. When nose wheel is straight or turned

Boeing 707 Production Line

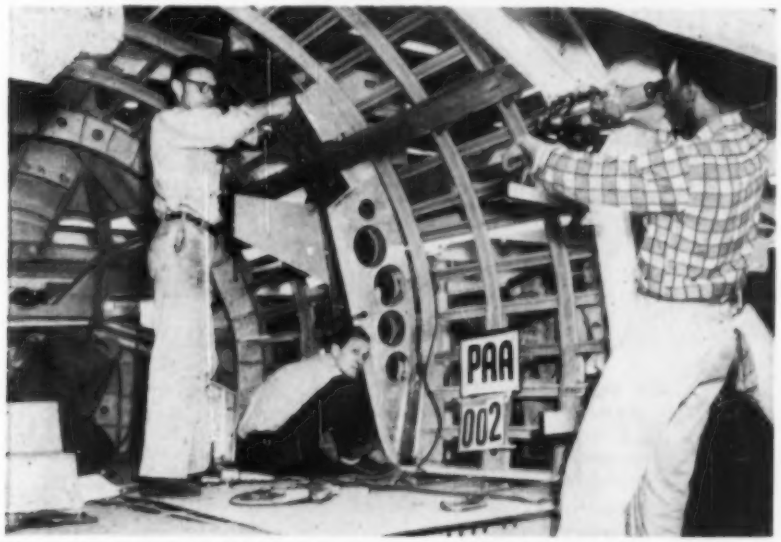


RIGHT inboard wing section of first Pan American jet 707 is positioned for joining with left inboard, wing center sections in Boeing Airplane Co. plant, Renton, Wash.

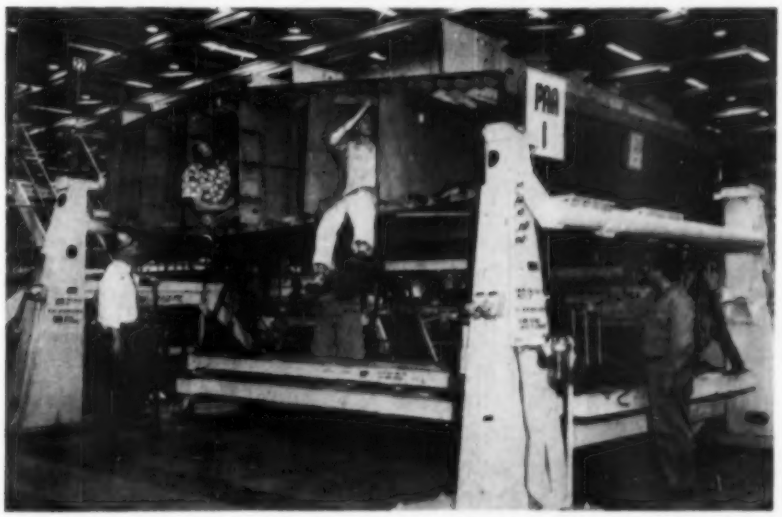


CENTER fuselage section of first plane is placed in pickup jig for detail finishing. Section will then be mated with forward fuselage and cab sections.

SKIN is attached to frame of second Pan American jetliner by workmen using cliquot fasteners to hold skin while it is being riveted to nose section.



CAB section of second 707 takes shape as workmen use transit to align a part. Pan American will begin taking deliveries in late 1958.



WING stub or center section of No. 1 undergoes final inspection prior to being joined with right and left inboard wing sections.

less than 45 deg., rear wheels are automatically locked in the trail position. It is particularly important that they be locked upon landing.

• **In a tight turn,** wing tip will swing on a radius of about 90 ft. and width of runway used by the main wheels is 87 ft.

• **Aero-screen,** a Douglas-developed, small, high-speed jet blast emanating from under the lip of engine pods, effectively prevents most cases of jets' ingesting foreign matter. Device, which operates at airplane ground speeds between 0-40 mph., when it shuts off automatically, reduces engine thrust by only .25%.

Douglas Aircraft and NACA agree that the device will substantially reduce ingestion damage which the Air Force says is responsible for nearly 50% of all its premature jet engine changes. Edwards told AVIATION WEEK that reverse thrust may complicate matters, however, since the reverse air blast can kick up gravel and foreign objects just as the engine is being accelerated and suction through the inlet increased.

• **Publicized need** for extra-long runways for jet transports exaggerates this requirement, according to Edwards. Longer runways will be needed only for a minority of flights. As examples, Edwards cited Johannesburg, elevation 5,050 ft., calling for 11,400 ft. of runway for maximum takeoff condition on a standard temperature day, 13,900 ft. on a hot day; Mexico City, elevation 7,340 ft., 11,900 ft. standard, 14,600 ft. on a hot day. A flight from Denver to Honolulu would require an 11,000-ft. takeoff runway on a standard day, 13,500 ft. on a hot day. Chicago to Europe would require 9,050 ft. standard, 10,200 ft. hot day.

For most flights, Edwards said, runways of 7,000-9,000 ft. length would be adequate.

Six Minute Deplaning

DC-8, as the 707, has been designed with two passenger doors, two doors opposite the passenger doors for food service, and with easy baggage and cargo access, Edwards said. Passengers deplaning should require six minutes, passengers enplaning 15 minutes. Six minutes should take care of removing luggage from the plane, 24 minutes for loading luggage.

Cargo should be unloaded in 15 minutes and loaded in the same amount of time.

DC-8's total engine-off turn-around time will not exceed 30 minutes, Edwards said.

Ground operation of the DC-8s should not cause serious noise problems, Edwards said, agreeing with Buck.

He suggested the use of blast fences and ear plugs for ramp personnel protection.

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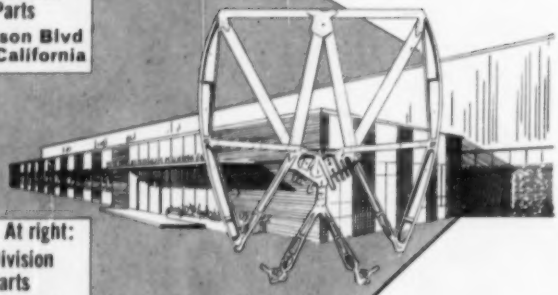

At right:
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Illustrated above are typical structural machined aircraft parts and assemblies currently being manufactured in the two divisions. The aircraft divisions operate under Air Force approved Quality Control systems. Each division possesses the most up-to-date equipment for its specialty including many pieces of equipment designed around a particular part. . . . . .

Convair B-58

Boeing B-52

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Russians Claim Best Turboprop

Vienna, Austria—The performance data recorded by the newest western turbo-prop aircraft are to be exceeded by Soviet Russia's newest model, the Ukraina, according to O. K. Antonov, chief constructor of the A. N. Tupolev aircraft construction team.

Antonov, in issuing a few data, attempted to demonstrate the planned superiority of this newest Tu class airplane to the Vickers Viscount.

The Viscount has the wings fitted to the bottom of the fuselage, the Ukraina will have the wings fastened to the upper sector of the fuselage. Both planes have four turbines which drive the propellers. The Ukraina is to have a seating capacity ranging from 60 to 80 and a cruising speed of 600 kph. (393 mph.), whereas the Viscount seats 40 and registers a cruising speed of 500 kph. (311 mph.). Fuel consumption of the Soviet type turbines is much lower than the Dart turbines of Rolls-Royce, as used in the British product.

Both planes have their best cruising altitude ranging between 8,000 and 10,000 meters above ground (26,246.4 to 32,808 feet, respectively). The Ukraina, owing to the greatly reduced weight (as compared with the Viscount), starts at short length both from concrete runways and from grass-surfaced runways.

Future plans call for the construction of a 180-passenger commercial transport also to be worked out by the Tupolev team in the near future, according to the Antonov statement.

Homemade Rocket

Impressive do-it-yourself rocket displayed by teen-ager Theodore Panayotoff was built by him for science fair. Pressurized oxygen-alcohol fuel powers the rocket, which he plans to launch this summer.

DC-8, Viscount Fleet Increased by TCA

Montreal—Trans-Canada Airlines has ordered two additional Douglas DC-8s and increased its Vickers Viscount orders by 13, raising the airline's fleet investment through 1959 to about $140 million. Its DC-8 orders now total six, its Viscounts received and on order total 51.

TCA's turbine fleet by 1960 also will include 20 Vanguards.

Two Super Constellations now on order will bring the total of this interim equipment to 11.

All the piston equipment, including the Lockheed planes, will be sold over the interim period. Six of the airline's 24 DC-3s already have been sold for late 1957 delivery.

Remainder of the piston fleet consists of 21 Merlin-equipped DC-4M North Stars.

The Men Who Are Air France

No. 6 Of A SERIES

CAPTAIN ANDRE LESIEUR

PILOT WITH A PAST—
AND A FUTURE

Captain Lesieur's past 10,000 hours of flight figure importantly in the future of Air France. His experience flying Super Constellations over the Atlantic (120 crossings) will smooth the integration of the new Lockheed Super Starliner into the Air France fleet. His hours at the controls of Comets and Caravelles will be indispensable in the coming changeover to jets. His well-rounded operational background is typical of the men of Air France. It is men like Captain Lesieur who will make it possible to carry on Air France's record of dependable service to the peoples of 73 countries in the generation ahead.

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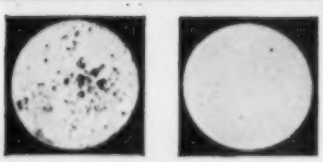
HUGHES Aircraft Company, faced a critical cleaning problem at their Tucson, Arizona, guided missile plant. Guided missile production demands the very highest precision.

Hughes tested the DETREX ultrasonic degreasing process (Soniclean*), found even the most minute parts came cleaner, faster than with any previous method tried. HUGHES' ordered, for immediate installation, a DETREX Soniclean* Degreaser.

DETREX Sonicleaning provides the answer to many difficult cleaning problems. In Sonicleaning, as in other metal cleaning and processing fields, DETREX is the established leader. Write today for complete information on DETREX Soniclean* Degreasing and other DETREX processes.

Offering the most complete combination of chemicals, equipment and services, DETREX can properly recommend, engineer and service the proper, specific application.

*Soniclean is the registered trademark of DETREX Chemical Industries, Inc.



Photomacrographs show results of DETREX Sonicleaning. Left panel shows .0250 grams of soil left after previous cleaning. Right, only .0002 grams remain after DETREX Sonicleaning.

DETREX

CHEMICAL INDUSTRIES, INC.

Box 501 • Detroit 32, Michigan

British Form Group For Air Travelers

London—Organization to represent air passengers has been formed in Britain, to be known as the International Society of Air Travelers and Air Transport Users.

It lists these objectives:

- **To care** for the legitimate interests, safety, comfort and convenience of air travelers.
- **To assist** in improving the volume, scope, regularity, usefulness and safety of air services.
- **To obtain** the abolition of all unnecessary delays and restrictions on air travel and transport.
- **To obtain** the abrogation of certain international and national legislative vexations for the air traveler.
- **To give** support to beneficial developments in civil aviation.

The group sees itself performing a function similar to that of automobile clubs for motorists.

First president is Lord Brabazon of Tara, holder of Britain's No. 1 pilot's license.

Transport Anxiety Stirs British Action

London—Council of Air League of the British Empire has set up a special committee to study organization, equipment and functioning of British civil air transport.

Chairman will be Sir Miles Thomas, former head of British Overseas Airways Corp. who now heads Monsanto Chemical.

One committee function will be to seek ways to improve the position of the independent airlines in Britain. Sir Miles Thomas says that as BOAC chairman he felt the independent airlines were so badly treated "that the private enterprise element could not get into the picture."

Spokesman for the group said it has been set up because of anxiety concerning Britain's position in the field of international air traffic and the inadequacy of its reserves of air transport for military purposes in an emergency.

Cubana to Receive Third Constellation

Companies Cubana de Aviacion (Cubana) will soon receive delivery of a third Lockheed Super-G Constellation to be used on the carrier's long distance routes between New York-Havana, Havana-Madrid and Havana-Mexico City. The aircraft will hold 86 passengers in mixed tourist-first class seating arrangement.

Nine of the 14 Lockheed aircraft in or approaching flight test: Front row—F-104A fighter, T2V-1 trainer, F-104B two seat fighter-trainer; second row—1649 Starliner commercial transport, WV2-E radar search plane, 1049 Super Constellation; back row—P2V-7 patrol bomber, Electra prop-jet transport, WV-2 radar search plane.

A fleet of Lockheeds for flight test engineers

Big assignment for flight test engineers and analysts: Test-prove a fleet of Lockheeds year after year.

The planes change, but there is always a varied fleet of aircraft demanding the ingenuity of Lockheed's Flight Test Engineering Staff. In such a diversified program engineers flight-test cargo and passenger prop-jet transports; jet fighters, trainers and interceptors; turbo-jet transports; bombers; radar search planes and unique aircraft such as the U-2 high altitude test plane.

The aircraft flying above represent an important share of Lockheed's current flight test program. At present 12 different models—an average of 30 planes—are in flight test. And coming soon—the important prop-jet Electra and 10 passenger turbo-jet transport projects.

Architect's drawing of Lockheed's new Burbank flight test engineering and experimental center. It will augment extensive flight test facilities now in operation at Burbank and Palmdale, California. It is scheduled for occupancy September, 1957.

This program of unmatched diversification has created a number of new positions on all levels for professional flight test engineers and analysts and instrumentation engineers. The brief résumé form below is for your convenience in contacting E. W. Des Lauriers, manager of Lockheed's Placement Staff.

E. W. Des Lauriers, Manager, Placement Staff

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Data Gives Estimate for Winged Missile

By K. D. Wood

Availability from NACA of data on triangular wings and wing-body combinations permits, by proper analysis, reasonably accurate estimates of the aerodynamic characteristics of certain missile configurations up to Mach 2.5, and also permits optimizing designs for a specified payload or performance with much greater confidence in flight-test-verifiability than has hitherto been possible from theoretical considerations alone.

This review of the data is done with a view to making quick and reasonably accurate performance estimates. It shows, by example, how the configuration of a hypothetical Mach 2.5 missile with payload of about 500 lb. may be optimized for maximum range.

Performance of a missile of a given weight (W) and thrust T (M. o. θ) (which is a function of Mach number and air conditions) is uniquely determined by the relationship between its drag coefficient $C_D = D/qS$ and its lift coefficient $C_L = L/qS$. For missiles such as the configuration shown in Fig. 1, it is customary to consider that S is S_w, the shaded area shown in Fig. 1, for either the wing alone or the wing-body combination, even though a substantial portion of the wing area S_{w_i} is inside the body.

The drag and lift coefficients of a specified geometric combination of wing and body are related by the equation

$$C_{De} = C_{De\,min} + (\Delta C_{De}/C^2_{Le})\, C^2_{Le}$$

where C_{De} min$^{(M)}$ is the minimum drag coefficient of the combination (a function of Mach number) and $(\Delta C_{De}\ C^2_{Le})^{(M)}$ is the "drag rise factor" (also a function of Mach number).

It is helpful in analyzing the data on wing-body combinations to consider also the relationship between lift coefficient and angle of attack

$$C_{Le} = (dC_L/d\alpha)_e \alpha$$

where $(dC_L/d\alpha)_e^{(M)} = a_e^{(M)}$ is the "lift-curve-slope" (also a function of Mach number).

A third equation involving pitching moments about the center of gravity of the missile is necessary to specify completely the forces in flight at zero yaw, and to study longitudinal stability and control, but this problem will not be considered here (though its solution is, of course, indispensable to satisfactory guidance of the missile) as this article is concerned only with performance of missiles.

The Author

Prof. Karl D. Wood, author of this analysis of winged missile data, is professor of aeronautical engineering at the University of Colorado, Boulder. He has had long experience in industry and government aviation posts as well as teaching, and is the author of text books and technical studies. His best known books are Airplane Design, distributed by the University of Colorado Bookstore at Boulder, and Technical Aerodynamics, published by McGraw-Hill.

Data on aerodynamic characteristics (C_{D_o} min. $\Delta C_{De}/C^2_{L\alpha}$ and $dC_L/d\alpha$) of missiles like Fig. 1, with a wide range of triangular ("delta" or "Δ") wings at Mach 1.50 and Mach 2.02 are given in NACA TN 3794 and 3795. These data are indispensable to this problem; they are an important contribution to the growing body of available data in this field because, for the first time, they permit accurate (flight-test-verifiable) estimates to be made, not only for test conditions but also for conditions and configurations which represent minor departures from the test values.

Good estimates can also be made, with the help of aerodynamic theory, for conditions and configurations which represent major departures from the test values, by the methods of analysis and synthesis presented here.

The method of analysis used is that graphical study is made of departures of data from simplified theory, and the departures are expressed semi-empirically (i.e., empirically but with consideration of the major physical factors involved).

It is helpful to study first the lift-curve-slopes ($dC_L/d\alpha$), because simple linear theory is in fair agreement with the data for wings without bodies, and the effects of adding bodies to delta wings are small (under 10% in nearly all cases reported in TN 3795), so that an error of 20% is permissible in estimating interference if the combined result is desired to within 2% accuracy (20% × 10% = 2%), which is adequate for engineering estimates.

Data on lift-curve-slopes of delta wings and wing-body combinations from TN 3795 are plotted in Fig. 2. Uniform scales have been used for 1/A and $d\alpha/dC_L$, resulting in straight line plots for both subsonic theory and subsonic data.

Note in Fig. 2 that supersonic theory and data also plot as straight lines, and transonic data (Mach 0.70 and Mach 1.10) from TN 3671 also plot nearly straight. Linear theory (broken) have been drawn for Mach 2.4 and Mach 3.0, beyond the range of the data, to permit reasonable extrapolations to Mach numbers beyond those for which test data are available.

Data are also plotted in Fig. 2 for wing-body combinations like those in Fig. 1. The changes in lift-curve-slope due to adding the bodies is seen to be very small (under 10% for 9 of the 10 plotted points). The changes are also

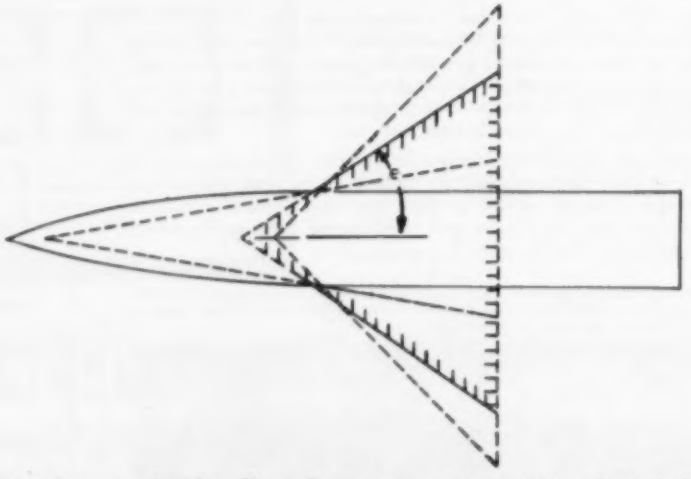

FIGURE 1: Data are plotted in Figure 2 (top, next page), for wing and missile body combinations as these variations, covering a wide variety of delta wings.

small compared with the discrepancy between wing data and linear wing theory, and the wing-body combination data agree with theory better than the wing-alone data.

For good engineering estimates it is desirable to use the data rather than the theory for wings alone, and to estimate, however approximately, the changes due to adding the bodies. A semi-empirical graph for estimating this small correction is shown in Fig. 3.

The reasoning behind the plot of Fig. 3 is a simple statement of the physical factors involved in the changes in lift-curve-slope due to addition of a body to the wing. The lift of the combination of wing and body is presumed to be obtained by adding three separate components:

- **Lift** due to body.
- **Lift** due to external wing.
- **Lift** due to portion of wing inside of body, which is reduced by the body to a fraction (f) of the lift that would exist if there were no body.

The calculated fraction (f), to agree with the observed data, is seen in Fig. 3 to plot nearly linearly against $(S_{w_1}/S_w)^2$. The maximum departure of f from the best fitting curve for each Mach number is seen to be under 8%, and the resulting error in estimating a_c is always under 4%, which is more than adequate.

Cross Plot

For making corrections to other Mach numbers than those for which test data are available, as is necessary to cover the full range of possible performance, it is desirable to have a cross-plot of Fig. 2 against M with A as a parameter. Such a plot is provided in Fig. 4. Note in Fig. 4 the well known uselessness of either subsonic theory (Prandtl-Glauert) or supersonic theory (Ackeret) in the transonic region from Mach .7 to Mach 1.3. Here the data are indispensable.

Fig. 4 is for wings without bodies; the small correction for body lift increment must be added from Fig. 3. The same scale for $dC_L/d\alpha$ has been used as in Fig. 3. Combined with the logarithmic Mach number scale, the results for small finite aspect ratios are practically straight lines, and this helps both interpolation and extrapolation. As noted in the graph, extrapolation beyond the limit of the Ackeret theory is not reasonable.

Data on minimum drag coefficient of wing-body combinations ($C_{D_{min}}$ min.) based on body frontal area S_b are plotted

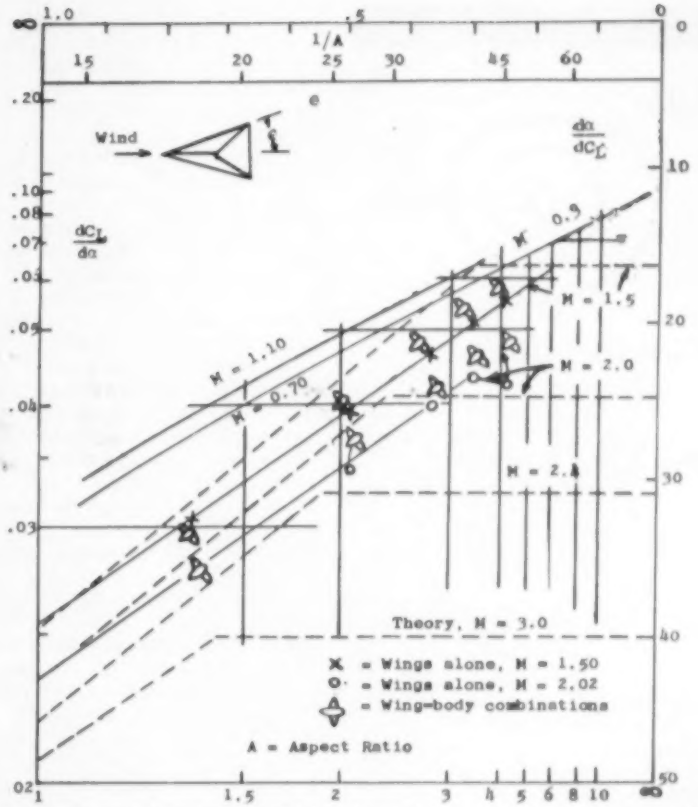

FIGURE 2: Data on lift-curve-slopes of delta wings and wing body combinations are plotted here. Broken lines are linear theory plots. For good engineering estimates it is desirable to use data rather than theory for wings alone and to estimate the changes which are due to adding the bodies.

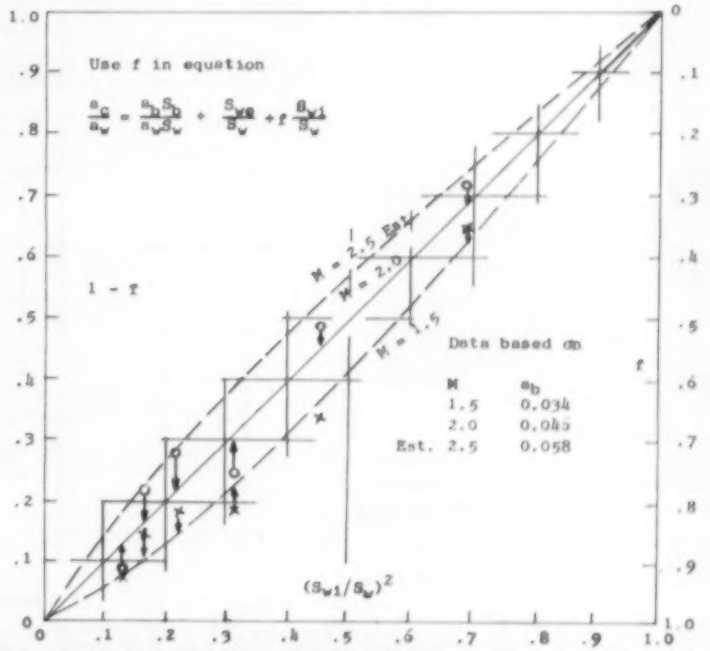

FIGURE 3: To estimate the small correction due to adding the body (see Figure 2, above), this semi-empirical graph has been provided.

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in Fig. 5 against the ratio of external wing area to body frontal area (S_{w_e}/S_b). Fig. 5 shows the minimum drag of a wing-body combination can be closely approximated by adding the drag of the wing area external to the body to the drag of the body, if the wing-drag coefficient is suitably increased to take account of interference effects. For the wing-body combinations studied here, it is found that a wing-drag coefficient 33% greater than that of the wing alone accounts for all combination drag coefficients within 2 or 3%. This accuracy is as good as that of most special wind tunnel tests and more than adequate for engineering estimates.

The total drag coefficient of a wing-body combination is seen from equation (1) to involve a minimum drag coefficient plus a "drag-rise" $(\Delta C_{D_c}/C^2_{L_c})(C^2_{L_c})$. This product may be termed the "induced drag coefficient" by analogy with subsonic wing theory, though it is more often referred to as a "wave" or "pressure" drag coefficient in supersonic theory.

The best condition of flight for long range requires that the induced drag coefficient be approximately equal to the minimum drag coefficient.

The drag-rise factor for wings alone and wing-body combinations such as are considered here is plotted in Fig. 6 as a function of aspect ratio with Mach number as a parameter. The agreement between "drag-rise factor" data and theory for wings alone studied here for Mach 1.5 and Mach 2 is seen in Fig. 6 to be only fair. While the average deviation of the experimental points from the theory is less than 10%, there are a few points that are over 20% off. The data on bodies with wings are, however, less scattering and the increments in drag-rise factor due to the addition of bodies to wings appear to be reasonably accurately predictable, as shown in Fig. 7.

The reasoning behind the drag-rise calculations in Fig. 7 is the same as that involved in the lift-curve-slopes of Fig. 2. It is assumed that the total drag-rise may be calculated by adding algebraically the drag-rises due to (1) the body, (2) the external wing, and (3) the portion of the wing inside the body, for which the lift is reduced by the factor f which was determined in studying the lift-curve-slopes.

The maximum departure of calculated from measured drag-rise is seen to be about 10%; since this departure is systematic, it can be corrected by reference to the graph, resulting in a net error of under 4%, which is as ac-

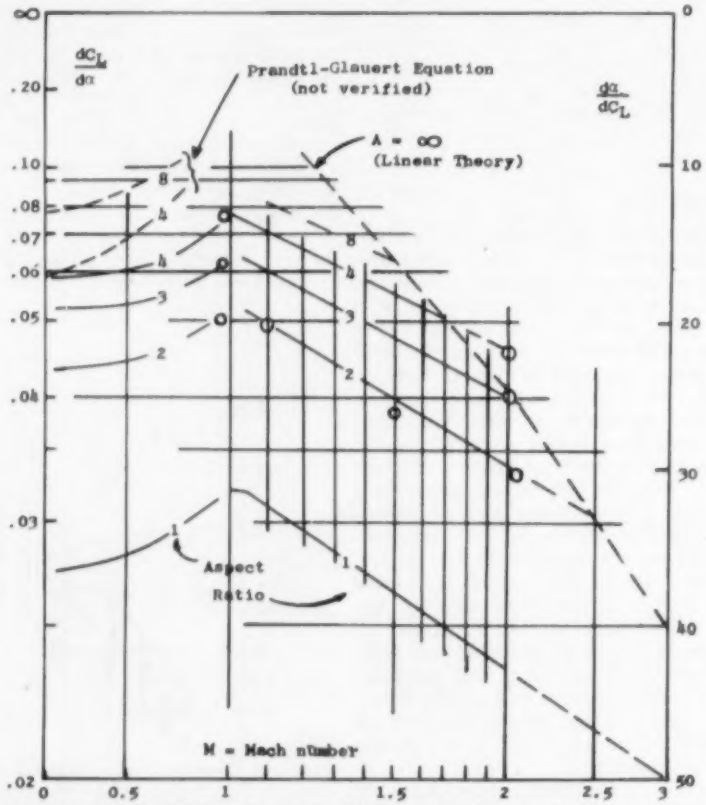

FIGURE 4: Cross plot of Figure 2 against Mach number with aspect ratio as a parameter helps to provide coverage of a full range of possible performance.

The vital role of business flying in American economic progress – and vital role of test-proven equipment in business aircraft fleets – is discussed with Fisher by Cessna Executives James Herrick, Fleet Sales, and T. Guy Miller, Sales Manager (L/R). They describe "excellent results" obtained with Champion Spark Plugs during rigorous flight-testing of this new 4-engine Cessna 620 pressurized executive transport . . . and confirm thousands of hours of safe flying with Champions in other Cessna models.

The nation's business aircraft fleets . . .

like the major airlines . . .

keep in flight fitness with CHAMPIONS.

Noted aviation authority reports on . . .

by
HERB FISHER
international aviation authority, veteran test pilot and author

Operation Business Flying

Operation Business Flying

Test Pilot Fisher (L), who flew this plane some 2,465 miles (Wichita-New York-West Palm Beach) with one fuel stop, hears of Champion's long-life dependability and easy accessibility to this Continental engine from Cessna executives, Bill Eikenberry and Bill Fergusson (L/R).

FAMILIARITY with volume testing and selecting of aircraft equipment by leading airlines sparked my curiosity about product performance and preference among individual units of the nation's vast business aircraft fleet.

For here we have a three-fold operational contrast between civil aviation's two largest bodies: Unlike the airlines, the great armada of private craft in the business aircraft fleet comprises nearly every make and model; individual business fleet crews themselves often rate performance and determine selection of their own aircraft equipment; and individual companies put their company-style planes to a variety of use quite beyond that of the airlines.

In looking into the matter with the National Business Aircraft Association, I was struck by the enormity of this non-airline fleet and by its importance in service to the national economy. That the airplane is now playing a commonplace and increasingly vital role in American business and industry was evidenced everywhere at the recent N.B.A.A. Annual Convention in Miami, Florida, attended by more than 600 pilots and executives from over the country. In my 28 years in aviation, I have never met any group more enthusiastic about the utility of the airplane as a safe, efficient working tool. Nor have I ever met pilots more keenly aware of their serious responsibilities regarding objective appraisal of the equipment they use.

I talked with scores of business pilots and executives and checked a lot of records to get the perspective of business flying's growth to maturity in aircraft equipment experience.

In singling out a representative functional plane part to trace in its development and modern-day application, I was struck by the overwhelming preference for Champion Spark Plugs in the multipurpose, multitype business aircraft fleet. The sizable cross section of pilots I objectively polled said they settled on Champions after extensive periods of trial-and-error with various types of spark plugs. They described familiar engine problems al-

Mike Murphy (L), Flight Operation Director, Ohio Oil Company, Findlay, Ohio, tells Fisher: "We've used Champions for many years without problems. I've been in this flying business a long, long time, and I know Champions are tops."

Chief Pilot Robert J. Kusse, Fruehauf Trailer Company, Detroit, recipient of N.B.A.A. Million Miler Safety Award, reports: "Our fleet (Lodestars, D-18's, Ventura, Norseman, Mallard and Bell Helicopter) is tailored for specific needs. Champions, we find, are tailor-made for all our specialized aircraft – and we use Champions in all. Never had any plug problems with Champions."

"Champions afford maximum utilization of our equipment. Champions' trouble-free operation unquestionably contributes to our high degree of on-time departures, an essential requisite in operation of a business fleet." Gerard J. Eger, Secretary, International Harvester Company, Chicago, and a board director of the N.B.A.A.

Dale Westfall, Chief Test Pilot for Cessna Aircraft Company, Wichita, Kansas, points up company policy regarding the new 4-engine Cessna 620: "Our top test-flight performance with the new 620 has included use of Champions from the beginning. My chief mechanic and I have found Champions performance-perfect."

"We received a Safety Award for flying 4,272,894 miles without mishap. Contributing to that record was the use of Champion Spark Plugs. We've had no plug trouble for six years – since using Champions." Ralph E. Piper, Chief Pilot, Monsanto Chemical Corporation, St. Louis, and a board director of the N.B.A.A.

A special report for Champion Spark Plug Company

"We have used Champions for 10 years in our Cessna, Beech and Lockheed fleet. They have always given us extremely good service." Chief Pilot Richard W. Smith, Champion Paper and Fibre Company, Hamilton, Ohio.

"Our fleet of airplanes flew 1,785,000 miles last year. The entire fleet has used Champion almost exclusively. Our millions of miles with Champions the past twelve years have shown us that they are safe and reliable." N.B.A.A. President Henry W. Boggess (L), Director of Aviation, Sinclair Refining Company, Tulsa, Oklahoma and Joe Lacey (C) Sinclair's Chief Pilot.

leviated only by proper application of Champions.

This singular experience with nearly all types of aircraft equipment – to procure the best parts possible for maximum efficiency in a wide variety of flying operations by a wide variety of plane types – is synonymous with business flying's spectacular development.

Few companies realized the advantages of operating their own business aircraft prior to World War II. Aviation equipment studies were unheard of in private business and industry. Of a total of 4,460,000 hours flown by all non-airline utility aircraft in 1941, only 250,000 hours were for business purposes while some 883,000 hours were recorded for pleasure flying.

At the war's end, however, with booming business competition and a shortage of airline transportation, ingenious business executives supplemented airline travel with company-owned and operated planes; many were former military transports. And such questions as, "What's the best equipment for us – the best spark plugs, for example?" became commonplace.

Private companies were then in the business of aircraft maintenance. Their plane crews found themselves in almost daily involvement in the procurement of aircraft equipment suitable to the company's specialized needs regarding plane types and operational purposes. Duties of the tailor-made fleet ranged from executive travel in multi-engine jobs to cross-country industrial map-making.

In 1955 the nation's vast business fleet had reached maturity in the application of aircraft parts and equipment to its varied operation. Our little barometer of trial-and-error product success – the Champion Spark Plug – had come into its own as an almost exclusive spark plug in many types of aircraft engines. Business flying chalked up an impressive 4,300,000 hours that year alone. And the hours continue to climb, holding promise of 5,700,000 hours by 1960 . . . 7,800,000 hours by 1965 . . . and 9,900,000 hours by 1970.

Thus, the small, almost insignificant business aircraft fleet of the early 1940's has become the mature giant of the late 1950's, overshadowing every other development in the field of transportation–a growth rate paralleling the progress of far-sighted industry and business. The business executive, salesman and engineer found new mobility–6,000 airports for his access by company plane as compared to but 600 terminal airports available by domestic carriers.

Today some 6,000 companies are using approximately 21,500 privately owned aircraft to transport their personnel and customers, and in many cases cargo, in the daily conduct of business. Some 2,400 are multi-engine aircraft, most of them equipped with the very latest in navigation and electronic equipment, as well as with Champion Spark

"Champion Spark Plugs are synonymous with dependability," Charles Morris (R), Chief Pilot, Socony Mobil, New York, tells Fisher (L). "Our 28-plane fleet operates all over the world. Champions guarantee top engine performance under any conditions." W. R. Dotter (Center), Chief Pilot, International Harvester, Chicago, reports: "Our fleet flies 800 hours a year per plane. We've used Champions from the beginning of our business flying 10 years ago and never have had any trouble with them."

"Nowhere in the history of a single test program has the DC-3 been put through three complete engine configurations as has this Challenger 250. We started with 92's, ran a complete 4B program plus 94's and R2000's. We pulled take-off horsepower with Champions for as much as seven continuous hours with no plug failures. This airplane has since flown through all kinds of weather and climate in North and Central America – and our Champion installations have proved without equal." So spoke Captain Jim Hurst, Executive Vice President of Aircraft Conversion Corporation, Detroit, a 12,000-hour pilot and former employee of Pan-American World Airways for 14 years. Pictured (L/R): H. C. Walls, Supt. of Field Operations, Miami International Airport; Captain Joe Clemow, Chief Pilot for Eastman Kodak, Rochester, New York; and Captain Hurst.

"We use Champions almost exclusively in our DC-3 and DeHavilland business fleet. We'll swear by them." Frank J. Dolinski, Chief Pilot, Aerojet-General, Azusa, California.

Plugs. There are also 19,000 single-engine planes and helicopters in business operation. The entire business fleet's record of safety and dependability is testimony to the proficiency of the pilots and efficiency of the aircraft and equipment they use.

Closely tied to the success of business flying is the N.B.A.A., organized in 1947 by 13 members operating 19 business airplanes. The N.B.A.A. represents the aviation interests of its members, presenting a united front in matters requiring organized action to improve aircraft, equipment and service, and furthering the cause of safety and economy in business plane operations. Present membership includes some 400 leading business organizations operating more than 1,000 aircraft, over 600 of which are multi-engine.

Champion staunchly endorses the N.B.A.A.

Proof of the N.B.A.A. member companies' adherence to the principles of safe operation of dependable aircraft and equipment lies in its annual Safety Award presentations. Twenty-nine pilots who had flown more than 1,000,000 miles each without accident or injury were honored at the Miami convention, as were 26 companies that had recorded a total of 47,036,788 consecutive accident- and injury-free miles flown with business aircraft. N.B.A.A. Safety Awards represented 121,908,052 hours of flying completely accident-free. Pilots emphatically told me that the attainment of such safety records would not be possible without the cooperation of the ground service operators throughout the country . . . and without the top-flight parts and equipment of American industry, such as Champions.

For their excellent cooperation in helping me obtain information at the Miami Convention, I wish to thank Bill Lawton, *N.B.A.A. executive director,* and his cheerfully efficient secretary, Corda Mae Cearnal, better known as "C.M."

— HERBERT O. FISHER

CHAMPION CONGRATULATES RECIPIENTS OF 1956 N.B.A.A. SAFETY AWARDS

Some of the pilots receiving N.B.A.A. Safety Awards for flying more than a million miles without accident or injury. Center is Miss Pat Walker, "Miss Business Aviation of 1956," and at her right, J. V. Swanson, Chairman of N.B.A.A. Awards Committee and Chief Pilot for Sears Roebuck.

N.B.A.A. Member-Pilot "Million-Miler" Safety Awards

1,000,000 OR MORE ACCIDENT- AND INJURY-FREE MILES FLOWN IN BUSINESS AIRCRAFT

NAME OF "MILLION MILER"	ORGANIZATION	CONSECUTIVE PLANE MILES FLOWN
ROBERT F. ALLEN	Frankfort Oil Company, Tulsa, Okla.	1,488,379
RAOUL CASTRO	International Harvester Company, Chicago, Ill.	1,153,039
L. P. CORNWALL	Chrysler Corporation, Detroit, Mich.	1,075,000
W. R. DOTTER	International Harvester Company, Chicago, Ill.	1,141,216
AL FAGER	Crane Company, Chicago, Ill.	1,071,000
E. W. ESTELLE	Esso Shipping Company, New York, N.Y.	1,516,250
HARVEY H. GLASS	Texas-Illinois Natural Gas Pipeline Co., Chicago, Ill.	1,296,000
ROBERT L. HANSEN	Krochler Mfg. Company, Naperville, Ill.	1,017,650
W. P. HOBSON	Hercules Powder Company, Wilmington, Del.	1,161,299
JACK C. JONES	Fairbanks, Morse & Co., Chicago, Ill.	1,800,000
JAMES E. KIDD	Anchor Hocking Glass Corp., Lancaster, Ohio	1,034,600
LOREN D. KIRBY	Universal Moulded Products Corp., Phila., Penn.	1,046,544
A. C. KORB	Westinghouse Electric Corp., Pittsburgh, Penn.	1,000,000
ROBERT J. KUSSE	Fruehauf Trailer Company, Detroit, Mich.	1,013,308
J. SHELDON LEWIS	Thatcher Glass Mfg. Co., Inc., Elmira, N.Y.	1,108,000
C. J. LUND	International Paper Co., Mobile, Ala.	1,151,700
S. M. MAXWELL	Burlington Industries, Inc., Greensboro, N.C.	1,107,915
B. OWEN MAYFIELD	Hercules Powder Company, Wilmington, Del.	1,370,619
GEORGE E. MEYERS	Monsanto Chemical Company, St. Louis, Mo.	1,150,000
N. L. MITCHELL	Minneapolis Star & Tribune, Minneapolis, Minn.	1,156,750
RALPH E. PIPER	Monsanto Chemical Company, St. Louis, Mo.	1,152,000
G. P. RIDER	Delta Drilling Company, Tyler, Texas	1,044,000
NELSON U. ROBES	Procter and Gamble Co., Cincinnati, Ohio	2,800,608
THOMAS J. SCHUETZ	International Harvester Company, Chicago, Ill.	1,140,969
G. W. SHERWOOD	Briggs Manufacturing Company, Detroit, Mich.	1,182,060
ORVILLE E. SPARKS	Holley Carburetor Company, Detroit, Mich.	1,019,024
D. M. TEEL	U. S. Steel Corporation, New York, N.Y.	1,017,000
R. N. THURSTON	Monsanto Chemical Company, St. Louis, Mo.	1,226,048
C. H. VON HOLLEN	Union Bag-Camp Paper Corp., Franklin, Va.	1,200,000

N.B.A.A. Member Meritorious Safety Awards

1,000,000 OR MORE ACCIDENT- AND INJURY-FREE MILES FLOWN IN BUSINESS AIRCRAFT

NAME OF ORGANIZATION	CONSECUTIVE PLANE MILES FLOWN
ANCHOR HOCKING GLASS CORPORATION, Lancaster, Ohio	1,450,000
ARMCO STEEL CORPORATION, Middletown, Ohio	1,174,248
BURLINGTON INDUSTRIES, INC., Greensboro, North Carolina	3,596,701
CHAMPION SPARK PLUG COMPANY, Toledo, Ohio	1,037,540
CLUETT, PEABODY & CO., INC., New York, N.Y.	1,597,500
COLUMBIA-GENEVA STEEL, San Francisco, Cal.	2,632,885
DELTA DRILLING COMPANY, Tyler, Texas	1,044,000
ESSEX WIRE CORPORATION, Fort Wayne, Ind.	1,267,000
ESSO SHIPPING COMPANY, New York, N.Y.	3,556,895
S. J. GROVES & SONS CO., Minneapolis, Minn.	1,110,000
HERCULES POWDER COMPANY, Wilmington, Del.	2,292,112
HOLLEY CARBURETOR COMPANY, Van Dyke, Mich.	1,286,852
INTERNATIONAL HARVESTER COMPANY, Chicago, Ill.	1,937,250
INTERNATIONAL PAPER COMPANY, Mobile, Ala.	1,897,557
KROEHLER MANUFACTURING CO., Naperville, Ill.	1,752,200
MINNEAPOLIS-HONEYWELL REGULATOR CO., Minneapolis, Minn.	1,635,000
MINNESOTA MINING AND MANUFACTURING CO., St. Paul, Minn.	1,421,969
MONSANTO CHEMICAL COMPANY, St. Louis, Mo.	4,272,894
OWENS-ILLINOIS GLASS COMPANY, Toledo, Ohio	1,816,265
THE PROCTER & GAMBLE COMPANY, Cincinnati, Ohio	1,584,754
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TEXAS GAS TRANSMISSION CORPORATION, Owensboro, Ky.	1,100,000
TEXAS-ILLINOIS NATURAL GAS PIPELINE CO., Chicago, Ill.	1,397,520
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UNITED STATES STEEL CORPORATION, New York, N.Y.	1,285,240
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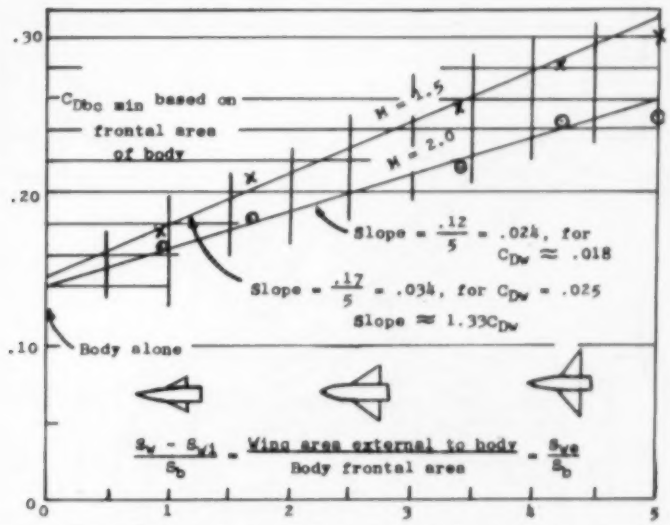

FIGURE 5: Data on minimum drag coefficients of wing body combinations based on body frontal area are plotted against ratio of external wing area to body frontal area.

curate a prediction as lift-curve-slope.

Extrapolation to Mach numbers beyond the tests is, of course, always less accurate, but the "drag-rise" is usually less than half the total drag, so the accuracy of prediction of total drag is more than twice as good and, for this set of configurations, very satisfactory for missile performance estimates.

With means now available for estimating reasonably accurately the numerical coefficients in the equations for C_{L_w} and C_{D_w} it is possible to make a performance estimate of a missile similar to Fig. 1, knowing only the geometry of the configuration and the conditions of flight.

Such an estimate is given below.

ESTIMATE EXAMPLE

An illustration of the use of the foregoing data in solving the problem of estimating the performance of a hypothetical winged missile similar to (but slightly different from) Fig. 1 is given below.

• **Data:** A missile is like Fig. 1 except in the following important respects:

(1) The wing dimensions are 12 times those of the model tested. Full scale dimensions are: s = semi-span = 2.75 ft.; c_r = chord at root = 4.10 ft.; S_w = total wing area, including portion inside of body = 11.2 ft.^{2}; A = 2.69; ϵ = 3.40.

(2) The body dimensions are only 10 times those of the model tested. Full scale dimensions are d = body diameter = 15 in. = 1.25 ft; S_b = body frontal area = 0.7854×1.25^2 = 1.23 ft^2; L = body length = 110 in. = 9.18 ft.; R = radius of ogive nose = 110.2 in., tangent to the body 42.5 in. aft of the nose; S_{wi} = wing area inside of body = $dc_r - (d/2)^2 \tan \epsilon$ = 4.54 ft.^{2} S_{wi}/S_w = 0.40; S_{we}/S_w = 0.60.

(3) The missile flies at M = 2.5 instead of the Mach numbers at which it was tested.

(4) The missile weighs 1,500 lb. including 500 lb. payload and 500 lb. of fuel. Turbojet powerplants are to be added at locations to be determined (probably on the wing tips).

• **Problem** is to estimate (a) the net thrust required from the powerplants to maintain level flight at Mach 2.5 at 40,000 ft. standard altitude, and (b) the maximum range of the missile if the jet powerplants have a specific fuel consumption of 0.8 lb.$_m$ fuel per hour per lb. of net thrust.

• **Solution** (obtainable, it is hoped, by any undergraduate student of aeronautical engineering having access to the foregoing information):

(A.) First estimate the aerodynamic characteristics of the missile at the specified Mach number. (Neglect Reynolds number effects for the present; these can be included by the methods of reference 3 if a more accurate estimate is desired.) This requires simple estimation of the three aerodynamic factors $(dC_L/d\alpha)_w$, $C_{Dc\ min}$, and $(\Delta C_{D_w}/C^2_{L_w})$, where the subscript ( )$_w$ denotes the combination of wing and body. When this has been done, equations (1) and (2) can be written with numerical coefficients.

To estimate $dC_L/d\alpha$, read in Fig. 2 for A = 2.7 and M = 2.5 a theoretical value of 0.033 for the wing alone; from the relationship between data and theory at M = 2.0, estimate that an experimental value of $dC_L/d\alpha$ would be slightly higher than this, say 0.035. To estimate the correction to lift-curve-slope due to the addition of the body, consult Fig. 3: calculate $(S_{wi}/S_w)^2 = 0.16$; read in Fig. 3, for M = 2.5, f = 0.78; calculate $a_wS_b/a_wS_w = (0.058 \times 1.23/0.033 \times 11.3) = 0.18$; calculate $a_w/a_w = a_wS_b/a_wS_w + S_{we}/S_w + fS_{wi}/S_w = 0.18 + 0.60 + 0.78 \times 0.40 = 1.09$; then calculate $a_w = 1.09a_w = 1.09 \times 0.035 = 0.038$. For test Mach numbers this would probably be within 3% or within 0.001 of the correct value. Because of the uncertainty of Mach number extrapolation on f, the error is judged to be possibly 5%. Hence, the estimated lift-curve-slope is 0.038 ± 0.002, and the lift coefficient equation is

$$C_L = 0.038\alpha \pm 5\%$$

To estimate $C_{D\ min}$ estimate first $C_{Dw\ min} = 0.014$ from the data in Fig. 5 at Mach 1.5 and Mach 2.0. Then calculate $S_{we}/S_b = (S_{we}/S_w)\ (S_w/S_b) = 0.60 \times 11.3/1.23 = 5.5$. The estimated $C_{Db\ min}$ (without wings) is 0.13 at Mach 2.5. Increasing $C_{Dw\ min}$ by 33% as in the other data, calculate $C_{D_{w\ min}} = 0.13 + 5.5 \times 1.33 \times 0.014 = 0.23$ (based on body area) or $C_{D_{w\ min}} = 0.23 \times 1.23/11.3 = 0.025$ based on wing area.

To estimate the drag-rise factor $\Delta C_{D_w}/C^2_{L_w}$, estimate first from Fig. 6 $\Delta C_{D_w}/C^2_{L_w}$ for wings alone at Mach = 2.5 and A = 2.7 as 0.58 (by interpolation). Data at Mach 1.5 and M = 2.0 are in fair agreement with theory (usually within 10%) around this aspect ratio. The correction for the effect of addition of body may be made by means of the equation given in Fig. 7. Items in this calculation follow.

• **Body Factor:**

$$\frac{\Delta C_{Db}}{\alpha^2}\frac{S_b}{S_w}\frac{1}{a_w^2} = 0.0010\ \frac{1.23}{11.5}\ \frac{1}{0.038^2} = 0.075 \approx 0.08$$

• **External Wing Factor:**

$$\frac{\Delta C_{Dw}}{C_{Lw}^2}\frac{S_{we}}{S_w}\left(\frac{a_w}{a_c}\right)^2 = 0.58 \times 0.60 \times \left(\frac{0.035}{0.038}\right)^2 = 0.29$$

• **Internal Wing Factor:**

$$\frac{\Delta C_{Dw}}{C_{Lw}^2}\frac{S_{wi}}{S_w}\left(\frac{a_w}{a_c}\right)^2 f^2 = 0.58 \times 0.40 \times \left(\frac{0.035}{0.038}\right)^2 \times 0.78^2 = 0.12$$

Adding these three factors gives a calculated:

$$\left(\frac{\Delta C_{Dc}}{C_{Lc}^2}\right)_{calc} = 0.08 + 0.29 + 0.12 = 0.49$$

Adding the same discrepancy between combination calculations and measured drag-rise factor as was

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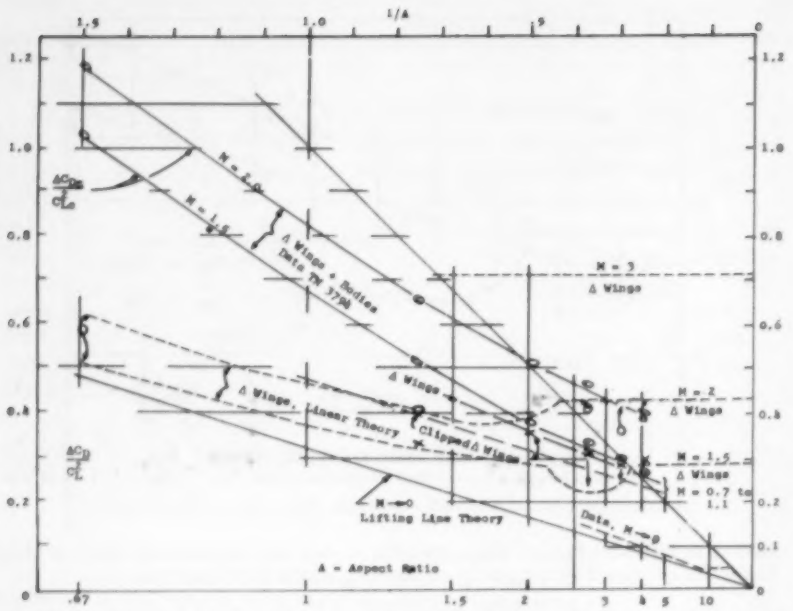

FIGURE 6: Drag rise factor for wings alone and wing body combinations is plotted as a function of aspect ratio with Mach numbers as a parameter.

found at M = 1.5 and M = 2.0, the estimated experimental value is

$$\left(\frac{\Delta C_{De}}{C_{L^2}}\right)_{est} = 0.49 + 0.05 = 0.54$$

The uncertainty of this figure, based on scatter of experimental data in Fig. 6, is about 10%, but the net error on C_D may be only about 5% for flight with "induced" drag only half the total drag.

Using the coefficients found in the last two paragraphs, the resulting drag coefficient equation is

$$C_{De} = 0.025 + 0.54C_{L^2}$$

(B.) Having an estimated drag coefficient equation, the calculation of thrust and range can proceed quickly. At the specified cruising altitude and Mach number, read in the tables of standard air (e.g., reference 3) $\rho = 0.000582$. Speed of sound = 971; calculate $V = 2.5 \times 971 = 2430$ ft/sec; $q = \rho V^2/2 = 0.000291 \times (2430)^2 = 1720$ lb/ft², and with $W/S_w = 1500/11.3 = 133$ lb/ft², calculate $C_L = W/S_w c = 133/1720 = 0.077$. The angle of attack for level flight is then

$$\alpha = C_L/a_c = 0.077/0.038 = 2.02^\circ$$

which is well within the 6° limit of the test data. The drag coefficient is

$$C_{De} = 0.025 + 0.54 \times 0.077^2 = 0.025 + 0.003 = 0.028$$

(Note that the "induced drag" is much smaller than the $C_{D\ min}$ term, which indicates that the wing area could be considerably reduced with improved performance; this possibility is discussed later under optimizing the design.)

The thrust necessary for steady level flight equals the drag, or

$$T = D = C_{De}S_w = \frac{C_{Dw}}{C_L} = \frac{0.028}{0.077}\ 1500$$

= 550 lb.

This thrust could be supplied by turbojets or ramjets on the wing tips or under the wings, each having a net thrust of 275 lb. This is the answer to part (a) of the problem.

The endurance with 500 lb. fuel and a fuel rate of $0.8 \times 550 = 440$ lb_m/hr. is $500/440 = 1.14$ hr. The range is approximately 1.14 hr. × (2430/1.467) mi./hr. or 1,890 miles. This can be improved by optimizing the configuration.

OPTIMIZING CONFIGURATION

Knowing the effect of geometric changes on aerodynamic characteristics permits studying in a reasonable length of time the effect of a large number of changes in the geometry of the configuration on the performance of the missile, so as to get the best missile for each Mach number.

Criteria sometimes used are:

- **Missile size,** weight, or cost to be minimum for a given mission (such as delivery of a specified payload at a specified speed along a specified flight path).
- **Most economical** speed and/or flight path to be determined for a given payload and range, taking account of the probabilities of failure and/or interception.

Where payload is a major factor in the criterion, there are needed not only aerodynamic data, but also a body of data on weights of component parts, since payload is usually defined as a

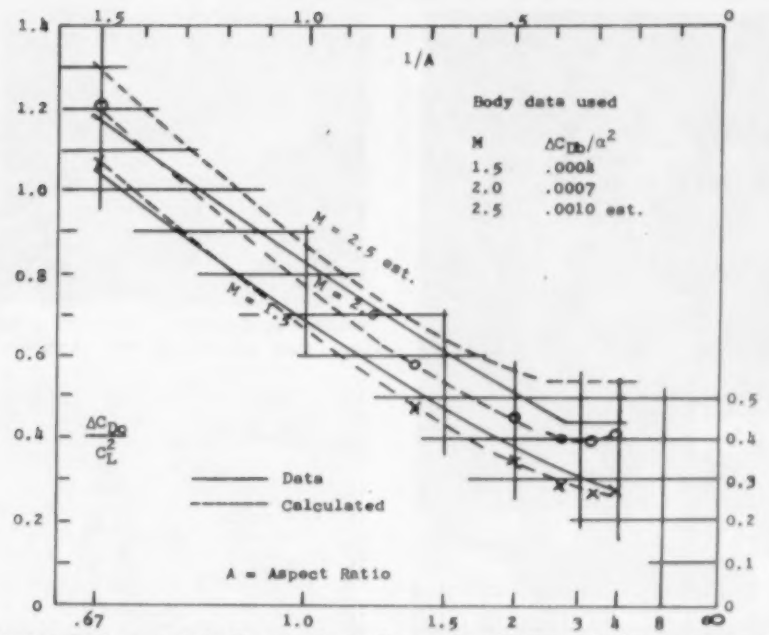

FIGURE 7: Increments in drag rise factor due to the addition of bodies to wings are reasonably predictable, as shown here, since data for them is less scattering.

difference between gross weight and weight empty (plus fuel weight). Some such data for aircraft are available, but missile component weight data that represent the best available current detail design practices are always very incomplete.

For a missile of a given weight and geometry, with lift and drag coefficients related by the typical general equation

$$C_D = k_1 + k_2 C_L^2$$

where k_1 and k_2 are functions of Mach number estimatable as above, either the wing area or Mach number may be determined so as to require minimum thrust (and hence minimum fuel for a given range, if an infinite choice of powerplants is assumed). If k_1 and k_2 are constants, as they are only if Mach number is constant, it may be shown that minimum drag for a given weight (C_D/C_L a minimum) requires that $k_2 C_L^2 = k_1$. One useful procedure is to optimize the wing area for each of a series of Mach numbers, though even this is not simple, because changing the wing area changes the wing weight and hence the payload if gross weight is constant. It is often a fair approximation, however, to neglect the effect of changes in wing weight on changes in payload, and to study later the error due to this approximation. The best configuration for each Mach number is thus determined; choice of Mach number is more complicated if probabilities of interception or failure are considered, as these always involve dubious assumptions.

For the missile of design Mach number = 2.5 previously studied, it has been noted that $k_2 C_L^2$ is very much less than k_1. This is because C_L is low; C_L can be increased by reducing the wing area for a given weight, Mach number and altitude. Using the numerical values previously given, if $k_2 C_L^2 = 0.54(C_L)^2 = k_1 = 0.025$ where C'_L is the new (optimized) lift coefficient, $C'_L = \sqrt{0.025/0.54} = 0.215$, and this requires that $\alpha' = C'_L/a_\alpha = 0.215/0.038 = 5.65°$ (about the upper limit of the test data). To get this value of C'_L instead of the original value of 0.077 requires dividing the wing area by a factor of $0.215/0.077 = 2.8$; the new wing area is $S'_w = 11.3/2.8 = 4.04$ ft.^{2} If the aspect ratio is kept constant at A = 2.69 ($\epsilon = 34°$), then the new wing span is determined by $(b')^2/S'_w = 2.69$, or $b' = \sqrt{4.04 \times 2.69} = 3.30$ ft. Unfortunately, with the new wing, the same body is much larger relative to the wing, and both $C_{Dc\ min}$ and $(\Delta C_{Dc}/C'^2_L)$ must be recalculated and a new calculation made of the best wing area; in fact, repeated calculations must be made, but the process converges and can be discontinued when the changes become small.

Another such series of calculations is also needed to optimize the aspect ratio of the wing. A single calculation is described here to illustate the process. To establish the new wing-body geometry, a sketch should be made and the various area ratios determined. The new wing turns out to be almost entirely inside the body. The coefficients are higher, the drag is less, but perhaps not as small as with an intermediate size of wing having less wing-

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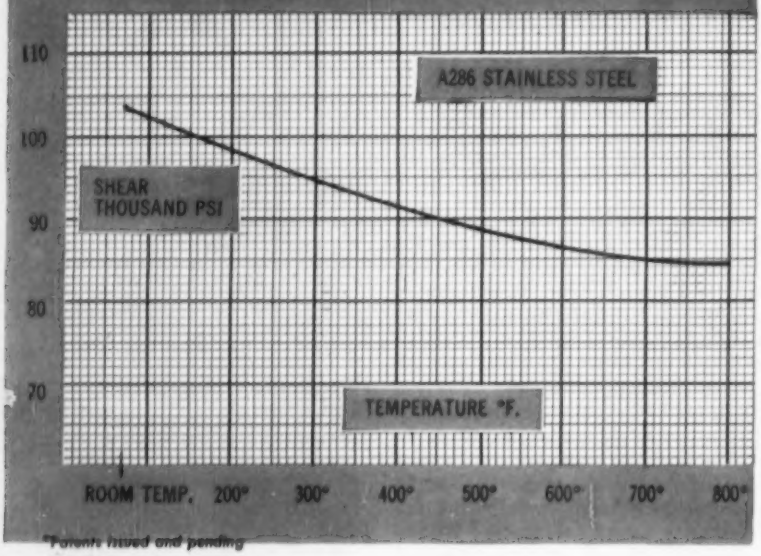

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FIGURE 8: Colorado students, using this data, built this vehicle, the "Irregulus."

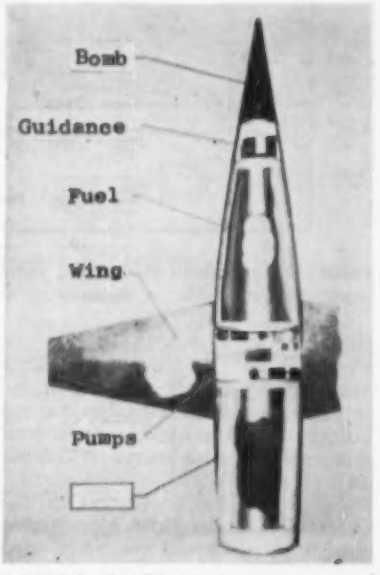


FIGURE 9: Possible interior arrangement of student missile is shown.

body interference. Hence, a series of intermediate wing areas must also be assumed and the minimum drag wing of this aspect ratio found by trial. Aspect ratio may be similarly optimized.

THE IRREGULUS MISSILE

Students at the University of Colorado have undertaken studies of this sort and come up with the missile configuration photographed in Fig. 8 and christened Irregulus (without apologies to Chance Vought, whose representatives visited us and seemed amused). Possible interior arrangement of the hypothetical missile is shown in the mock-up built for public display and photographed in Fig. 9.

Some visitors have suggested the name Comarc as more appropriate than Irregulus, as the resemblance to the Bomarc missile is more striking, and the University of Colorado as well as Boeing has ties with the University of Michigan, which gave the M to Bomarc.

While the Irregulus looks plausible, it should be admitted that the optimizing process described above was dis-

continued in favor of production because of delivery date deadlines. Some professional missile manufacturers will admit that some of their optimizing, too, has had to be postponed in favor of delivery dates.

The point is that relatively inexperienced persons can develop fairly good missile designs with a minimum of aerodynamic background if they have a good collection of data on wing-body combinations. The NACA is certainly to be commended for starting a program of this sort; and it is hoped NACA will be able to attract the manpower to continue it. Optimization of the Irregulus was fairly obviously discontinued not only for production; the necessary data were not available even if there had been time.

More data are needed; only 24 points have been plotted herein; 240 would be more convincing. Some wing data with the same planforms but different wing sections are in disagreement with the data given here; the effect of wing section needs investigation, but a worthy start has been made.

Swedes Fire First Naval Unit Missile

Sweden continues to debate how guided missiles will fit into its defense program. One concrete disclosure amid the outpouring of opinion is that the Swedish Navy recently fired its first guided missile for use against naval units from a destroyer.

Development work on missiles began 10 years ago in Sweden, but appropriations indicate it has been on a modest scale, an indication which has created demand for a reorganization.

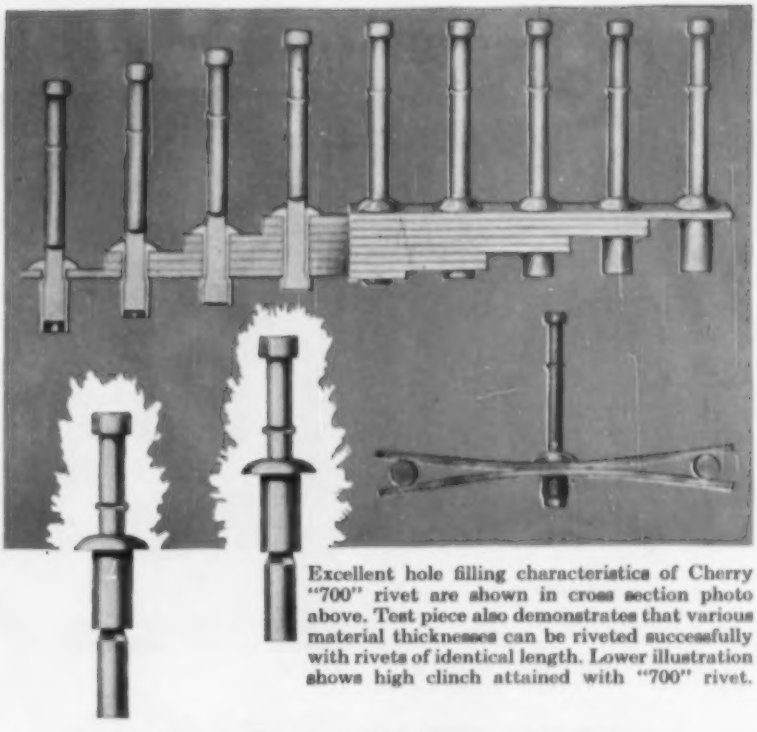
One military man, Col. Harald Jentzen, emphasizes that only absolutely necessary and economically realistic projects should be included in the Swedish program, and that as many such weapons as possible should be purchased abroad.

In Britain, where the government formally announced a turn-to-missiles policy, the Society of British Aircraft Constructors, proclaimed at the same time that the British Aircraft Industry now has these missiles for sale:

- **Fairey Fireflash,** air-to-air missile being promoted in NATO nations.
- **Bristol Bloodhound,** ground-to-air weapon.
- **De Havilland Firestreak** infrared homing air-to-air missile.

The Armstrong Whitworth sea-to-air weapon Seaslug may also become available for export when a full production order is placed following further trials.

Swedish views favor construction work being left to private industry in the strictly limited type program envisioned.



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Work Begins on First IRBM-ICBM Base

By Irving Stone

Cooke AFB, Calif.—Ground-breaking ceremonies here initiated construction of the first strategic ballistic missile base in the United States.

Primary mission of the facility, according to Brig. Gen. Osmond Jay Ritland, vice commander, Western Development Division (ARDC), who spearheaded the ceremonies, will be to provide training of ballistic missile units. Second mission will be to provide an operational facility for intercontinental ballistic missiles.

At some future date, after Cooke AFB operation gets underway, there will be a phasing of the total effort to Strategic Air Command.

Three Divisions

Missile itself is only one-third of the total effort for attainment of ballistic missile capability, Ritland declared. Another third of this effort is in the ground support equipment, and the remaining third is allocated to technical facilities such as launch platforms, control stations, storage facilities and other supporting structures.

Modernized runway will be constructed at the base to provide air terminal facilities in support of the ballistic missile activity, Ritland said.

In Fiscal 1957, about $30 million will be spent on Cooke construction and rehabilitation, and a similar amount will be expended in 1958. Total program effort will approximate $100 million in the foreseeable future, Ritland revealed.

Timetable provides that by December, 1958, several thousand military and civilian personnel will be housed in the general area of the facility. Approval has been obtained from Department of Defense for construction of 880 Capehart houses on Air Force property. Work will start on these units in September and is scheduled for completion by the end of June, 1959. These houses will not fulfill all needs, and more will be needed by December, 1958, for off-base accommodations.

Unit Assigned

Commander of the Cooke complex will report to Maj. Gen. Bernard A. Schriever, WDD commander. Already activated at Cooke is the 392nd Air Base Group (only 15 people now) to provide initial and continuing maintenance and support as base construction progresses. Other squadrons will be added to this group for support functions, and eventually training squadrons will be installed.

Ballistic missiles in the Air Force

AERIAL view shows Cooke AFB headquarters area, being renovated for billeting. Reservation is about 168 mi. northwest of Los Angeles on Pacific Ocean. The first U. S. strategic missile base, the facility will primarily train ballistic missile units. Its secondary mission is to provide an operational base for ICBMs. In Fiscal 1957 and 1958, $30 million will be spent each year for construction and rehabilitation.

TOPOGRAPHIC MAP shows Cooke AFB, and the surrounding area near Lompoc, Calif. Primary mission of base will be to train ballistic missile units.

13 more VISCOUNTS ordered by TRANS-CANADA AIR LINES

Mr. Gordon McGregor, President of Trans-Canada Air Lines, announces that TCA is adding thirteen new Vickers Viscounts to their fleet. Since their initial order for 15 in November, 1952, TCA's total Viscount fleet now on order stands at 51—of which 25 have already been delivered. Mr. McGregor says, "In my opinion the Vickers Viscount is by a very wide margin the best commercial aircraft of its class that has ever been built."

Why TCA bought more Viscounts...

In TCA's first year of Viscount service, its over-all load factor rose to a record 81%. And in more than two years of service, the Viscount's load factor has averaged over 80%.

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TCA learned what so many other airlines have also learned: "*wherever the Viscount flies . . . traffic figures rise.*" Result: over 30 airlines have ordered Viscounts—and, of the 15 now operating Viscounts, 10 have already increased their orders.

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• AMS - 6371	• AN-T-69	• AMS - 6372	• MIL-T-5066
• MIL-T-6736	• AN-WW-T850a	• MIL-T-6735	• AN-WW-T846

SERVICE STEEL • DETROIT, MICHIGAN LOS ANGELES, CALIFORNIA

program—intercontinental range Convair, Atlas, and Martin Titan and intermediate range Douglas Thor—along with the ground support equipment phase of the effort are well under way and proceeding close to established schedule, Ritland said.

WDD, established to expedite the top priority Air Force ballistic missile effort, is complemented by Air Materiel Command's Ballistic Missile Office to expedite procurement and contractural matters, and Guided Missiles Research Division of Ramo-Wooldridge Corp., which is responsible for systems engineering and technical direction of the overall program.

Atlas and Titan ICBMs are closely interrelated to the point of using many common components, even though they represent two different design approaches to enhance the probability of attaining early operational capability.

Prime Contractors

There are now 16 prime contractors in the Air Force's ballistic missile effort, together with study and various other contractors and government agencies, supported by more than 200 major subcontractors.

One of the most difficult problems in the ballistic missiles field is development of a nose cone to withstand temperatures generated by hypersonic reentry speeds. General Electric Co. is contractor for the Atlas nose cone. Avco Mfg. Corp., Everett, Mass., another nose cone contractor, has been conducting research with large shock tubes to simulate re-entry. Third member of the nose cone team, Lockheed Aircraft Corp., has gathered re-entry data with the X-17 test vehicle.

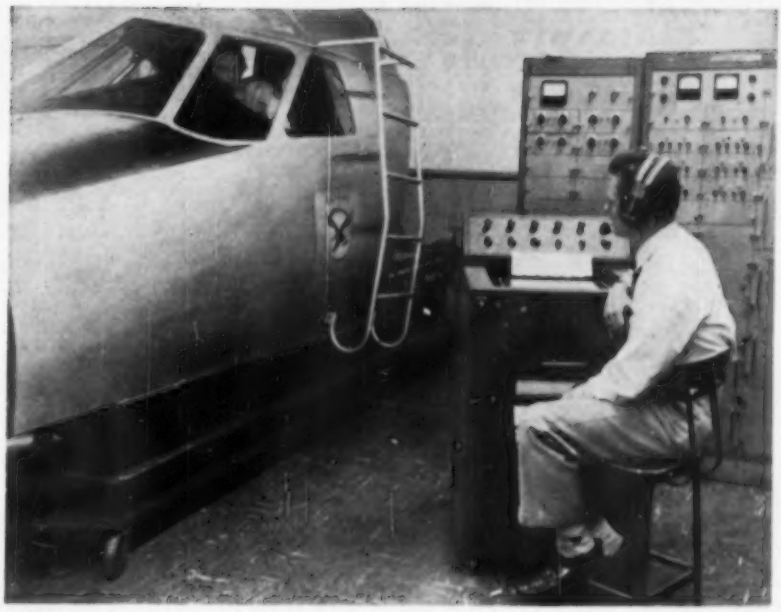
Hypersonic test vehicles launched at Holloman Air Development Center by Aerophysics Development Corp., also have yielded re-entry data.

Terrier Launching System Contract Awarded by Navy

Northern Ordnance Inc., Minneapolis, has been awarded $23 million in Navy contracts to build launching equipment for the Terrier anti-aircraft guided missile. The systems will be installed on new aircraft carriers, guided missile frigates and the Navy's first nuclear-powered guided missile cruiser.

Decaborane Production Begun at Nevada Plant

American Potash & Chemical began production of decaborane in pilot plant at Henderson, Nev. Decaborane, a high-energy compound of boron and hydrogen, generates 28,000 Btu./lb., has possible aircraft chemical fuel application.



COCKPIT SIMULATOR and analog computer are used in B-58 flight control system tests.

B-58 Simulator Program Aided Development of Control System

Ft. Worth—Convair is using a flight simulator as a basic tool in the development of the B-58 flight control system. The machine has also proven a valuable means of preflight familiarization for B-58 test pilots.

With the B-58 simulator, Convair was able to "fly" the supersonic bomber on the ground for two years before it actually made its first flight last November with B. A. Erickson, Convair chief test pilot, at the controls.

Development of the B-58 control system can be traced from early flights with an F6F at National Advisory Committee for Aeronautics' Ames Laboratory through subsequent flight tests with other aircraft and earthbound flight tests in the simulator. Erickson worked closely with Convair engineers through the entire program.

Control system program began late in 1952 when Convair took B-58 parameters obtained in wind tunnel tests and simulated the embryo bomber's flight characteristics with a specially modified F6F at Ames. Similar flights were conducted at Ames with an F-86. F-86 work was more valuable because the fighter is turbine powered.

Then Convair went to Cornell Aeronautical Laboratory and used a specially rigged F-94 to simulate B-58 characteristics. Here, Convair worked on stick characteristics as as part of a joint Convair-Cornell-Air Force program.

The simulator was specifically designed for development work on the B-58 control system. It was of primary value in working out rough spots in the control system by discovering flaws and testing fixes before the system was committed to actual flight.

John Goode, Convair's chief of aerophysics, estimates that 99% of the changes in the control system's design came from the development program conducted with the simulator.

First flight of the B-58 was mapped out in the simulator, as were subsequent test flights. Erickson practiced the first flight for a month in the simulator before he took the B-58 up.

While the simulator's function was basically limited to development work on the delta-wing bomber's flight control system, some aspects of airframe design from the control standpoint could be tested. A simulated supersonic engine failure, for instance, could give valuable data on the stability of the tail structure.

At Ft. Worth, a simulator was built and rigged with a prototype B-58 control system. The bomber's controls were designed and built for Convair by Eclipse-Pioneer Division of Bendix Aviation Corp.

A second prototype control system was installed in an F-89 at Ft. Worth and tested in a program that extended over 120 flights. Erickson flew in all these test aircraft at Ames, Cornell and Ft. Worth.

Two years before first flight, Erickson was able to simulate B-58 flight in the

PUMP PRIMERS

GEROTOR aircraft pump can handle several different fluids and functions simultaneously

The unique construction of the Gerotor type pump permits aircraft systems designers to combine *several pumping* functions in a single pump housing mounted on a single pad and driven by a single shaft.

▸ **Basically** a form of internal gear pump, the Gerotor has only two moving parts: an inner toothed element meshing with an outer toothed element. The inner Gerotor has one less tooth than the outer and the "missing tooth" provides a chamber to move the fluid from the intake to the discharge. (See Fig. 1). The volume of the chamber multiplied by the number of driver teeth and RPM determines the quantity of fluid pumped.

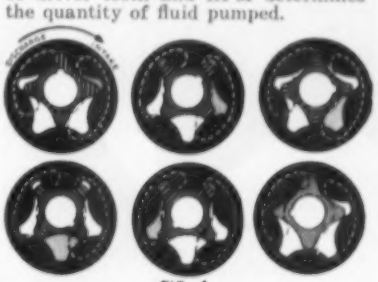


FIG. 1

▸ **Both Gerotor elements** are mounted eccentric to each other on the same shaft. This structure permits stacking a number of sets of Gerotors along the same shaft, in a common housing. By simply providing each set with a separate compartment and inlet and discharge ports, several fluid systems can be served simultaneously and without interference. (See Fig. 2). Different capacities can be provided for each system despite the common driving shaft speed by varying the diameter or thickness of the Gerotor elements to vary the volume of the tooth chamber.

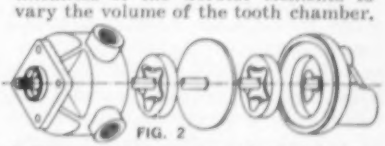


FIG. 2

▸ **Diversified systems** such as lubrication, scavenging, low pressure hydraulic servo systems and motors up to pressures of about 1000 psi may be centralized in this manner and multiple pump installations avoided.

▸ **Advantages** – The Gerotor is a positive displacement pump. It is simple and compact, lightweight, valveless, provides high volumetric and mechanical efficiency and offers exceptional performance at high altitudes.

▸ ***Technical Data** – is available and your inquiry is invited. Write:*

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Especially chosen as a vital telemetering component to meet the stringent requirements for Convair's high-flying USAF B-58 *Hustler*, the Hoover Model 10015 Subcarrier Oscillator is the precise observer of a variety of flight test data. This unit reliably provides stability with variations in temperature, altitude, shock, vibration and humidity. Compact in size (1¾ x 1³¹/₃₂ x 4¾ inches), the Model 10015 is now being produced in substantial quantity. Detail specifications, price and delivery will be furnished promptly on request.

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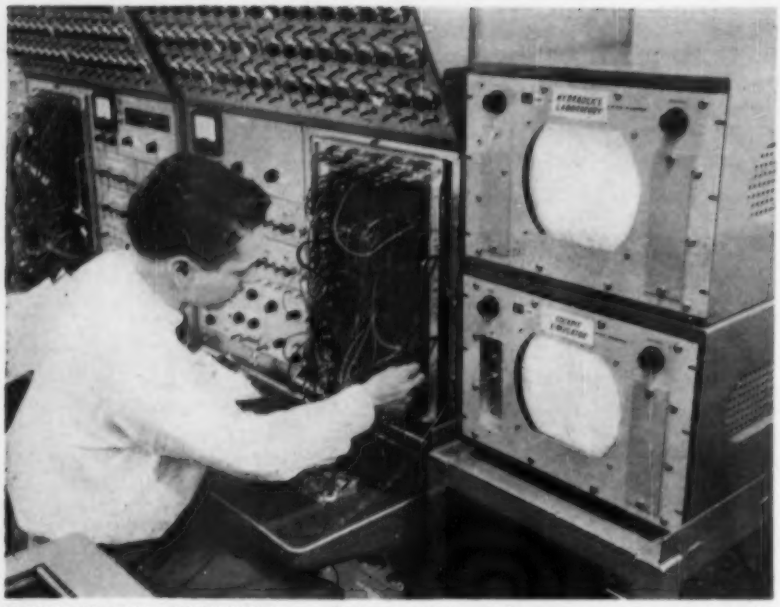

CLOSED CIRCUIT TELEVISION is used along with the analog computer in control checks.

simulator with prototype flight system, and four months before first flight an actual B-58 flight system was installed in the simulator. Erickson had about 75 hours on the simulator before he flew the B-58.

Simulator cycle begins in a mockup of the B-58 flight compartment. This pilot's cockpit is complete down to throttles which can electronically simulate engine thrust.

Cockpit controls are linked to an actual B-58 control system. This power control linkage package contains damping servos, autopilot servos, feel springs and mechanical linkage arrangement.

Control movements are transmitted from the system to an analog computer which solves flight motions and produces readings on cockpit instruments to show aircraft reaction to control movements.

Computer also transmits this data to a movable platform which it drives. This table simulates dynamic motion of the aircraft and has sensing elements which reproduce changes in rate and indicate displacement position on the platform, following the flight of the simulated B-58.

Gyros then send this sense back to the autopilot, to the computer and then to the cockpit instruments just as actual B-58 gyros would record sensations in actual flight. More extensive data is transmitted to recorders for engineers to study.

Part of the simulator is a separate test panel which has duplicates of some of the pilot's controls, plus equipment for individual components and sequences. This installation gives capability of checking modes of operation not normally used in flight, but which provide added information for system evaluation.

Closed circuit television set is mounted on the nose of the simulator in front of the left side of the windshield to show the pilot computer traces from the computer room next door. A second TV circuit shows the computer room what the dynamic table is doing. The simulator installation is also equipped with an intercom system.

The simulator could easily serve as the basis for a training simulator for the bomber. Such a training machine would be simpler than Convair's present simulator since it would not need the extensive test equipment now in use.

Non-Stop F-100Cs Averaged 450 Mph

Los Angeles—Three Tactical Air Command F-100Cs, using KB-50 probe-drogue tankers, flew the 6,710 mi. from London to Los Angeles nonstop at a average speed of more than 450 mph. during their 14 hr. 5 min. aloft.

Using low frequency navigation aids over water and ground control intercept over the U.S., the planes flew between 37,000 and 40,000 ft. for most of the route at cruise power for the J57 turbojets of approximately 92% power.

Over eastern Texas, a drogue from one of the tankers struck the canopy of the aircraft piloted by Capt. James Bryant, smashing it and forcing a reduction to approximately 25,000 ft. altitude for the remainder of the distance. Five refuelings were necessary en route.

ENGINEERING BULLETIN
ON MICRO-BEARINGS
Miniature Instrument Ball Bearings

NEW HAMPSHIRE BALL BEARINGS, INC.
PETERBOROUGH 1, NEW HAMPSHIRE

Subject: BEARING FITS AND FITTING PRACTICES

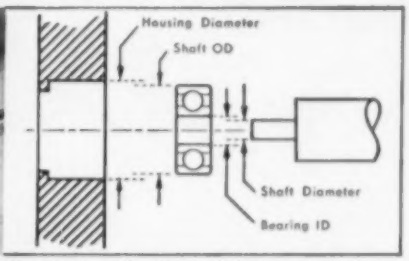

FIG. 1 Principle factors involved in fitting Micro-Bearings. Handling and fitting tools such as furnished by the Baker Co., Maplewood, Maine, enable operators to place or remove Micro-Bearings quickly, easily and help avoid damage.

As shown in *Fig. 1*, the fitting of Micro-Bearings, like the fitting of larger ball bearings, chiefly involves the clearances between the inside diameter of the housing and the outside diameter of the bearing; the bore of the bearing and the diameter of the shaft. Obviously, proper handling and fitting is an important factor in assembling the bearing to both shaft and housing.

Arriving at workable clearances is the subject of this bulletin.

RECOMMENDED FIT

In view of the absence of standards for shaft and housing fits in assembling instrument bearings, this data sheet is based on experience of users who are heavily involved in fitting problems. For example, the use of interference fitting *tighter than line to line* is not recommended for the majority of applications.

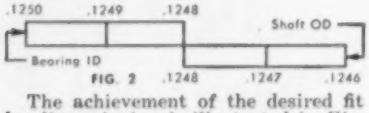

FIG. 2

The achievement of the desired fit by dimensioning is illustrated in *Fig. 2*. The bearing ID is represented by the top blocks and the shaft OD is represented by the lower blocks. Such a block diagram could also be applied to housings and bearing outside diameters. In this block diagram, it will be noted, the bearing ID is represented by a 0.0002" tolerance with a similar tolerance for the shaft. A resulting fit of line to line to .0004" loose is shown.

An interference fit *not* tighter than line to line is suggested for the following reasons:

1. *Difficulty in assembly.*
2. *Difficulty in disassembly. This is often more hazardous than the assembly operation and may result in total bearing destruction.*
3. *Reduction in radial play.*
4. *Danger of bearing ring conforming to possible poor geometry of mating shaft or housing.*

TOLERANCE DISTRIBUTION

The maximum 0.0004" loose condition shown in *Fig. 1* may be excessive in some applications. The fitting problem then resolves itself to reducing this extreme, and yet maintain the *maximum* tight fit of line to line. The looseness may be reduced by redimensioning the shaft to 0.1249/0.1247 as

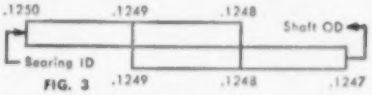

FIG. 3

shown in the block diagram, *Fig. 3*. If the frequency distributions of shaft and bearing ID sizes were statistically normal, the modal fit of all parts would be 0.0001 loose. Accordingly, an insignificant percentage of parts would be mated to the extreme values, and for practical purposes could be ignored.

With regard to bearings' outside diameters and bores, however, normality of the distribution curve *cannot* be assumed. During the grinding operation, the "most metal tendency" tends to skew the frequency distributions for bearing ID's and OD's in the direction of most metal.

In grinding and finishing shafts and housings, similarly skewed distributions occur.

Operating on a modified probability distribution of tolerance is possible if the volume of parts is sizeable. But the approximate distribution of shaft and housing sizes *must* be verified if this method is to be used.

MATERIALS and SURFACE FINISHES

The ease of assembly is also affected by materials and finishes. The following factors must be considered:

1. *The galling characteristics, hardness and ductility of the materials involved.*
2. *Finish lay patterns produced by various tools and techniques used.*
3. *RMS surface finish values achieved.*
4. *Geometry of shafts and housings as regards out-of-roundness, taper, etc.*

The possible combinations of these elements in any single application are so numerous that their gross effect can only be ascertained by trial and error, or by a detailed study of operations on individual applications.

SIZING METHODS

Close tolerance fitting may be achieved by performing supplementary sizing operations on housings or shafts by the following methods:

"Bearingizing Tools" manufactured by the Cogsdill Tool Products, Inc., have been used on both housings and shafts, and potentially yield the greatest accuracy in the shortest period of time *(Fig. 4)*. A — Shaft sizing tool operates by peening oversize shafts to proper diameter. B — Internal Bearingizer enlarges housing holes to proper diameter.

"Ball sizing" has been used with a fair degree of success on through holes. This is essentially a swaging operation utilizing hardened steel or carbide balls.

While shafts may be polished by hand this is an expensive operation and may jeopardize good shaft geometry.

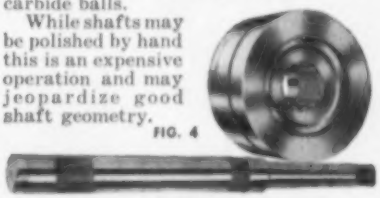

FIG. 4

CODING

Segregation of all parts into .0001 increments has been advanced by some bearing users as a solution to fitting problems. Upon request and for an additional cost, NHBB will code a given shipment to the following table.

DESCRIPTION	CODE	BORE TOLERANCE	O. D. TOLERANCE
LARGE BORE LARGE O. D.	11	+ .0000" − .0001"	+ .0000" − .0001"
LARGE BORE SMALL O. D.	12	+ .0000" − .0001"	− .0001" − .0002"
SMALL BORE LARGE O. D.	21	− .0001" − .0002"	+ .0000" − .0001"
SMALL BORE SMALL O. D.	22	− .0001" − .0002"	− .0001" − .0002"

Coding is not a general solution to the problem of fitting. Experience has shown that unless assembly techniques can cope with the existing distribution of bores and OD's within their .0002 spread, an unbalanced stock situation results in the user's plant.

Manufacturing to closer boundary dimension tolerances is not recommended at the present state of the art. It is not usually feasible to mass produce bearings to a .0001 tolerance spread. It is generally necessary to produce some two to four times the quantity of parts desired to fulfill such requirements on the basis of selection from a standard .0002 tolerance. When a user of bearings relies solely on coding of parts, a procurement and stocking problem is eventually created.

Close collaboration between the bearing manufacturer and user is necessary in planning to meet fitting problems since neither one alone has access to complete knowledge or control over all the variables involved.

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The Air Force's new jet transport tanker, the Boeing KC-135, matches the performance of jet combat aircraft to provide faster, more efficient refueling. This, in turn, extends the potential striking range of both fighter and bomber aircraft. The Stratotanker's 400-cycle, automatic, paralleled electrical system is driven directly from the engines by Sundstrand Constant Speed Drives. Reliability inherent in the custom-design of the Sundstrand Drive insures peak performance for the KC-135 in carrying out its vital mission. Its light weight helps provide maximum flight capability. Application of Sundstrand Drives to provide the Stratotanker with a high-capacity, stable electrical system results from the record for reliability that makes Sundstrand *first* in constant speed drives.

ONE OF MANY MODELS

The "Package-Type" drive shown at right is slung from the underside of the KC-135's engines and is shaft-driven from the waist gearbox. More than 20 different models of Sundstrand Drives have been installed in virtually every major type of aircraft.

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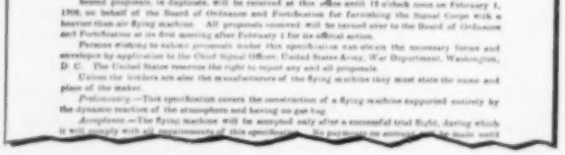
On December 23, 1907, the Department of War issued specifications for a "heavier-than-air" flying machine. Here's an excerpt from one of the specs:

> **"The flying machine should be designed to have a speed of at least 40 miles per hour in still air . . ."**

Today, this kind of speed is strictly for the birds. Which brings up another problem. When a bird hits an airplane windshield (or vice versa) something's got to give. And it had better be the bird. L·O·F's skills and developments in safety glass are providing greater protection than ever before in today's high-performance airplanes. Good examples: Lockheed's new Prop-Jet "Electra" and Douglas' new Turbo-Jet DC-8.

If you have any question concerning the latest developments in aircraft glass, send it to Aircraft Division, Dept. 7357, Libbey·Owens·Ford Glass Company, 608 Madison Avenue, Toledo 3, Ohio.

ALSO ASK FOR A COPY OF *The Original American Army Contract for Aeroplanes* suitable for framing.



SIGNAL CORPS SPECIFICATION, NO. 486.

ADVERTISEMENT AND SPECIFICATION FOR A HEAVIER-THAN-AIR FLYING MACHINE.

To the Public

Sealed proposals, in duplicate, will be received at this office until 12 o'clock noon on February 1, 1908, on behalf of the Board of Ordnance and Fortification for furnishing the Signal Corps with a heavier-than-air flying machine. All proposals received will be turned over to the Board of Ordnance and Fortification at its first meeting after February 1 for its official action.

Persons wishing to submit proposals under this specification can obtain the necessary forms and envelopes by application to the Chief Signal Officer, United States Army, War Department, Washington, D. C. The United States reserves the right to reject any and all proposals.

Unless the bidders are also the manufacturers of the flying machine they must state the name and place of the maker.

Preliminary.—This specification covers the construction of a flying machine supported entirely by the dynamic reaction of the atmosphere and having no gas bag.

Acceptance.—The flying machine will be accepted only after a successful trial flight, during which it will comply with all requirements of this specification. No payments on account will be made until

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Supersonic Escape Capsule Completed

By George Christian

Denver—Supersonic escape capsule prototype has been completed by Stanley Aviation under a contract with USAF's Wright Air Development Center.

Although designed specifically for Convair's F-102A delta wing fighter, the capsule can be adapted to a number of Air Force or Navy supersonic fighters, according to the company.

Capsule enables the pilot to leave his plane in a pressurized, air-tight, watertight cocoon to protect him from supersonic air blast, violent deceleration, anoxia and extreme cold. Device is ballasted to float right side up if it lands in water and contains survival equipment and food to help the pilot stay alive regardless of landing location.

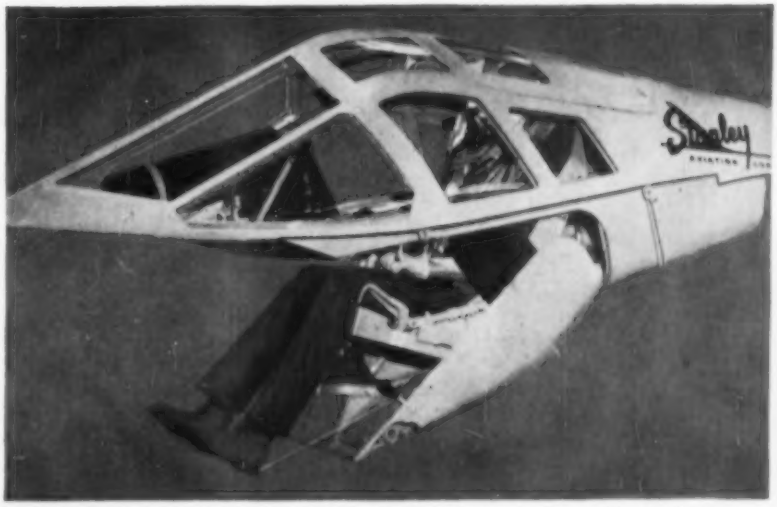
The aluminum-and-glass capsule is 14 ft. 2 in. long, 3 ft. high and weighs 1,000 lb.

To separate the capsule from the plane, pilot squeezes one of two shielded triggers below the arms of his seat. All succeeding actions are performed automatically:

- **Bar under the pilot's knees** snaps up and yanks his feet off the rudder pedals into the clamshell bottom of the capsule.
- **Clamshell closes and locks,** tilting the seat and pilot backwards into a feet first, horizontal position.
- **All controls in the cockpit** are automatically severed as clamshell closes. The control stick stays with the pilot.
- **Four connections** holding the capsule to the plane slide free and the enclosure is blasted from the plane by a 9,000 lb. thrust rocket tube.
- **Set of fins in the tail** snaps out to stabilize the capsule and keep it from tumbling.
- **Elevator-type fins** give the capsule a 20 deg. angle of climb.

Half a second after separation from the plane, a small drogue chute is deployed behind the capsule. The chute serves several purposes: it stabilizes the capsule in pitch and yaw, slows it down, and measures dynamic pressure on a cable leading to the capsule. Cable is attached to the main, 48 ft. diameter parachute through a force-altitude sensing device.

When the force senser determines that the capsule has slowed sufficiently to avoid shredding the main canopy and the altitude monitor senses that the capsule is at a predetermined altitude,



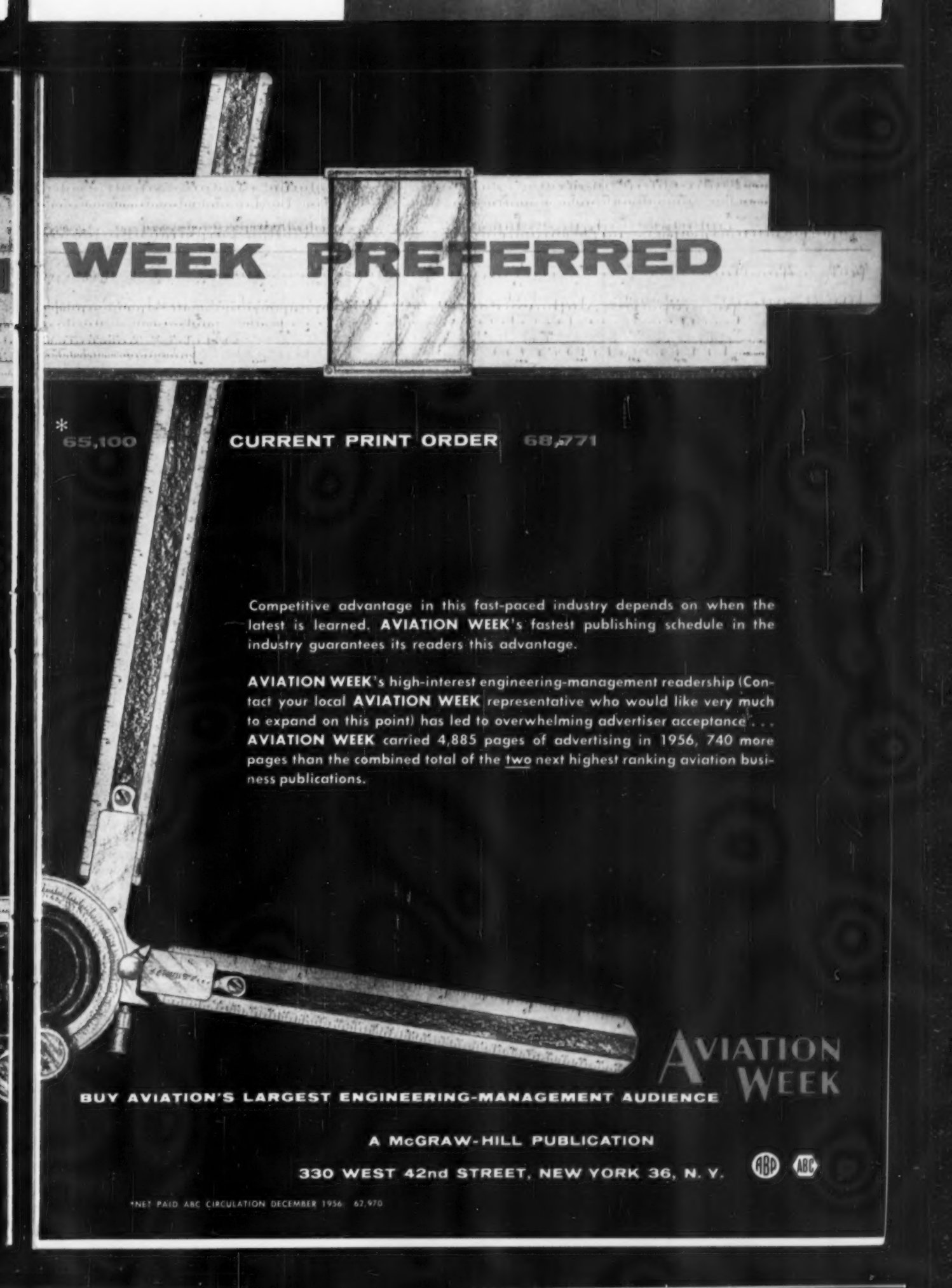
PILOT in normal position in capsule (above). Note foot retraction cables on heels.

CAPSULE starts to close (above) retracts feet, rolls pilot back. Sealed capsule below.

CURRENT PAID CIRCULATION

MAKE NO MISTAKE . . . Aviation's biggest news today consists of the latest scientific and engineering developments which make possible tomorrow's aircraft. The prime source for this vital information is **AVIATION WEEK** . . . preferred by aviation's engineeing-management men because . . .

Working to fulfill their "need to know" are 24 full-time editors — graduate engineers and aviation specialists. They possess the technical knowledge and industry experience needed to ferret out, analyze and report in detail aviation's significant technical developments when they happen.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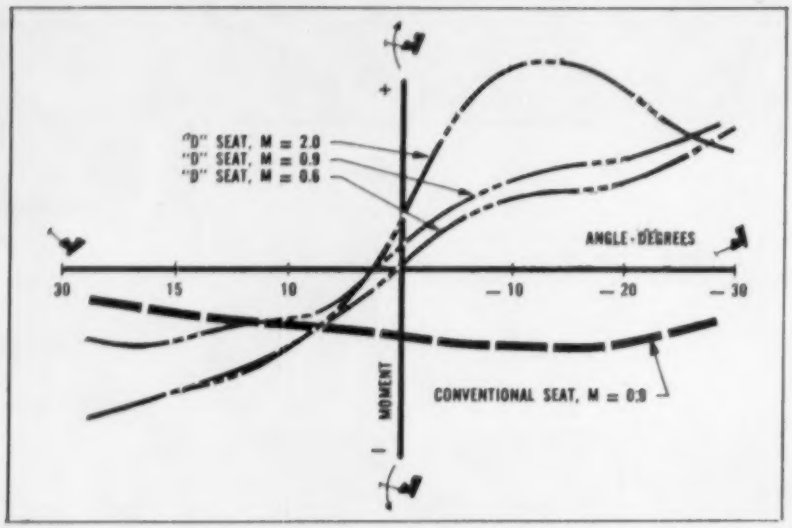
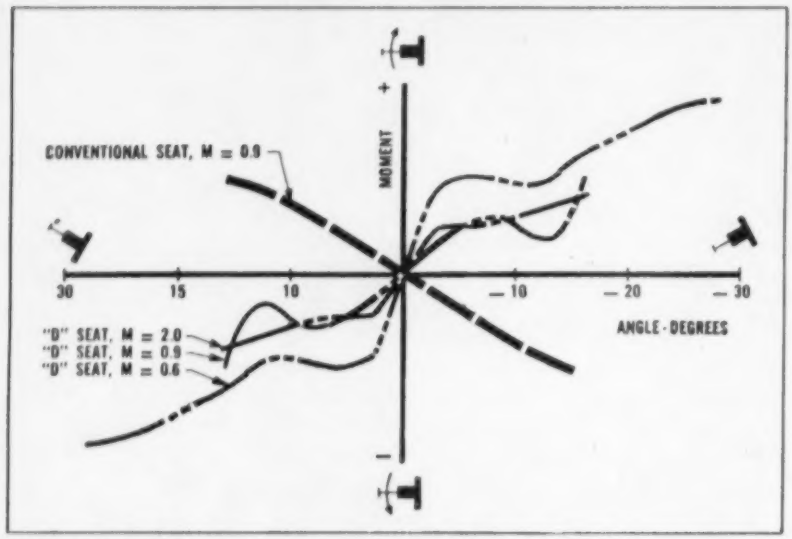
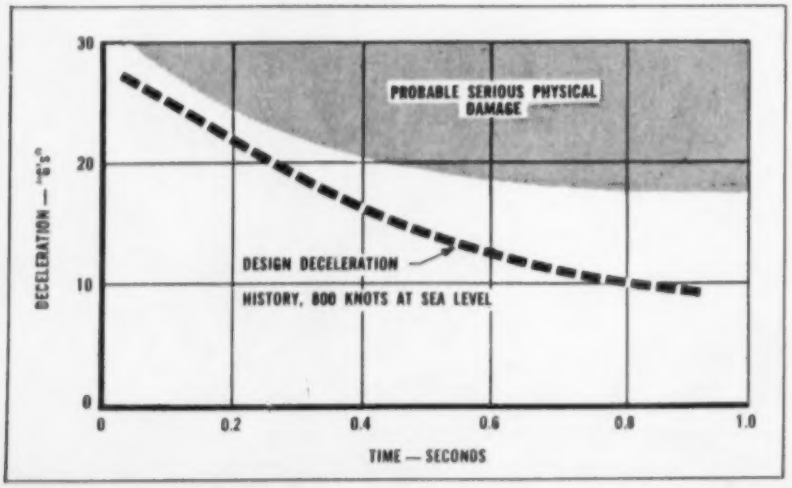


PITCH stability of D-seat is compared with conventional seat at Mach 0.6, 0.9, 2.0.



DIRECTIONAL stability of D- and conventional seats is shown in this chart.



DESIGN deceleration values of D-seat are less than recognized conservative body limits.

the main chute is deployed. The capsule hangs from the shroud lines nose down, putting the prone pilot in a sitting position.

After floating to earth, the pilot can release the chute by pulling a D-ring. He can leave the capsule either through the top hatch normally used to enter the plane, or through the clamshell doors in the bottom.

Parts of the capsule have been tested on 1,000 mph. rocket sleds at Hurricane Mesa. Further tests will be made this summer with the completed capsule containing anthropomorphic dummies.

Capsule development is part of a multi-million dollar USAF program to provide safe supersonic escape systems for military pilots. Evaluation of the program will take place this fall (AW May 6, p. 94).

Capsule's advantage over a D-seat is potentially greater than a D-seat's advantage over a conventional seat (AW May 6, p. 94). The two seats' characteristics are compared in charts at the right.

Importance of capsules as escape systems is that, at the present state of the art, they represent the only means of keeping a man alive if he has to escape under one or more of these circumstances:

- **Speeds of** 2,000 mph. and over.
- **Altitudes** exceeding 75,000 ft.
- **Geographical locations** ranging from equatorial heat to arctic cold.

Moreover, Stanley engineers feel that although the problems of hypersonic escape are a little too advanced for today's state of the art, it is possible that during the next decade the human brain may be used as part of a missile guidance system. This will mean that some means of crew escape will be required as operational routine, as well as under emergency conditions, at speeds and altitudes which are literally outside of this world.

Big boon which supersonic pilot will derive from capsules is being able to strip himself of much of his cumbersome personal equipment and "fly in his shirt sleeves." Stanley spokesmen stress the importance of this factor. They point out that a pilot no longer straps on his parachute and goes flying. He must strip virtually to the skin and put on layer after layer of specialized clothing, until finally, with his pressurized anti-G suit, pressurized helmet, crash helmet, life preserver, oxygen mask, bail-out bottle, etc., he becomes a lumbering creature almost as awkward as a medieval knight in full armor. If the trend continues, there is apt to be a revolt and a demand that things be made simpler once more, the Stanley spokesmen contend.

With a capsule, not only can the pilot fly in his shirt sleeves, but stowage space can be made available for such

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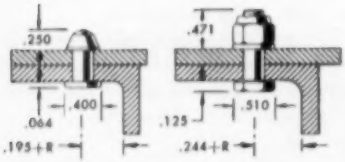
In weight comparison between HI-SHEARS and high strength close tolerance bolts, per thousand pieces and using a ¼" diameter—⅜ grip length—4650 lbs. shear, the bolt-nut-washer weight is almost double that of HI-SHEARS.

HS52P-8-6	Steel Hi-Shear Pin	9.25
HS15-8	Alum. Hi-Shear Collar	1.32
		10.57 lbs.

HAS464P4A7	Steel Bolt	17.35
AN365D428	Alum. Nut	3.40
AN960PD416L	Alum. Washer	.90
		21.65 lbs.

Even substituting a 40% lighter titanium bolt for the steel bolt, the bolt-nut-washer combination is still heavier than the HI-SHEAR by 4.14 lbs. per thousand pieces.



Substantial weight savings are also gained by the use of smaller fittings through reduced clearances required by HI-SHEARS.

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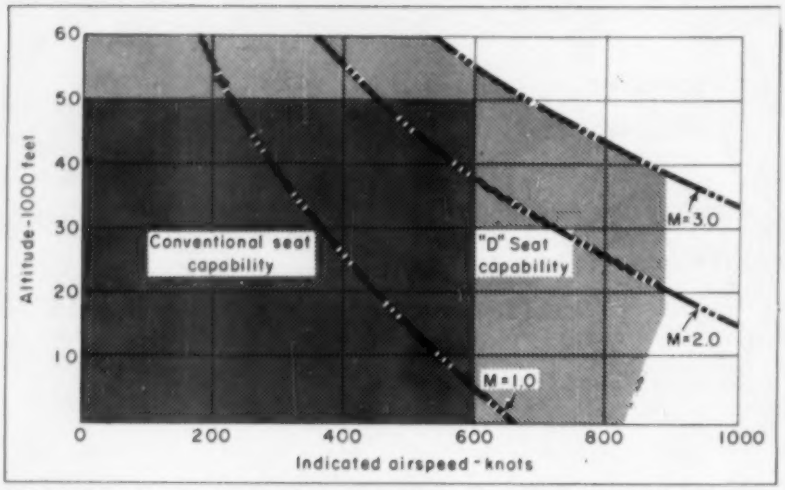

CHART shows how D-seat capabilities exceed those of a conventional seat in both speed and altitude at speed ranges of Mach 1, 2 and 3.

necessary survival paraphernalia as food, water, drugs, clothing and life raft.

Zoom to Survival

Added benefit of the capsule (AW May 6, p. 94) is that if traveling fast, it has good low altitude survival characteristics. Reason is that the fast-travelling, 1,000 lb. capsule has a lot of kinetic energy to be dissipated. This factor, coupled with its inherent high mass/drag and lift/drag ratios, give the enclosure an excellent potential for zooming to an altitude at which the main chute can be safely deployed. To do this, however, the capsule will have to incorporate a stabilizing mechanism which can tell the device which way is up to avoid zooming into the ground if separation from the plane occurs in an inverted position.

The high mass/drag ratio also provides good insurance against too-rapid deceleration injuring the pilot.

Although the first capsule built by Stanley is of the canopy type—where the canopy is the basic structure of the capsule and the pilot is sealed in underneath it—the company is also studying the nose type. In this design, used on the Bell X-2, the whole nose of the plane separates from the fuselage rather than just the canopy and associated structure.

Escape From Davy Jones

Antithesis of high altitude escape—not zero altitude ejection but underwater ejection at an estimated depth of 12 fathoms—was recently accomplished successfully by an F4D-1 pilot. Brake failure after landing on board the carrier USS Essex caused his plane to roll over the side after his arresting gear had been disengaged.

During its 55-ft. drop into the ocean, the plane rolled over and slapped into the sea on its back. The pilot, dazed by impact with the water, suddenly realized that water was cascading into the cockpit. He used the manual locks to unfasten the canopy. Then, realizing the futility of trying to escape by pulling himself out of the cockpit, he seized the face curtain and ejected himself.

He was not conscious of the ejection itself, during which his oxygen mask lost its retaining strap on one side. He found himself clear of the aircraft and was able to free himself of the seat since the automatic seat belt release had worked correctly. He swam an estimated 75 ft. to the surface, helped by the buoyancy of his parachute. When he surfaced, the pilot estimated that the carrier was a good 1,000 ft. away from him. He was almost immediately retrieved by a helicopter.

Navy Conclusions

Some conclusions: the pilot had been underwater about 1½ minutes, yet he was not aware of any restrictions on his ability to breathe. The canopy was probably shattered upon impact with the sea, since water rushed into the cockpit and the pilot's flight clothing was full of glass splinters. Moreover, the metal reinforcing strip running fore and aft across the center of the canopy did not interfere appreciably with the pilot's ejection. However, bruises and cuts on the pilot's legs, arms and torso indicate that some obstructions hindered his ejection. Tightness of his lap belt and shoulder harness saved him from injury upon impact.

Douglas Aircraft has been conducting underwater canopy release tests for about a year in a 24-ft. deep, 64,000 gal. tank on A4D, F4D, and F5D canopies. Company told AVIATION WEEK that further tests at greater depths must be conducted before conclusive results are obtained.

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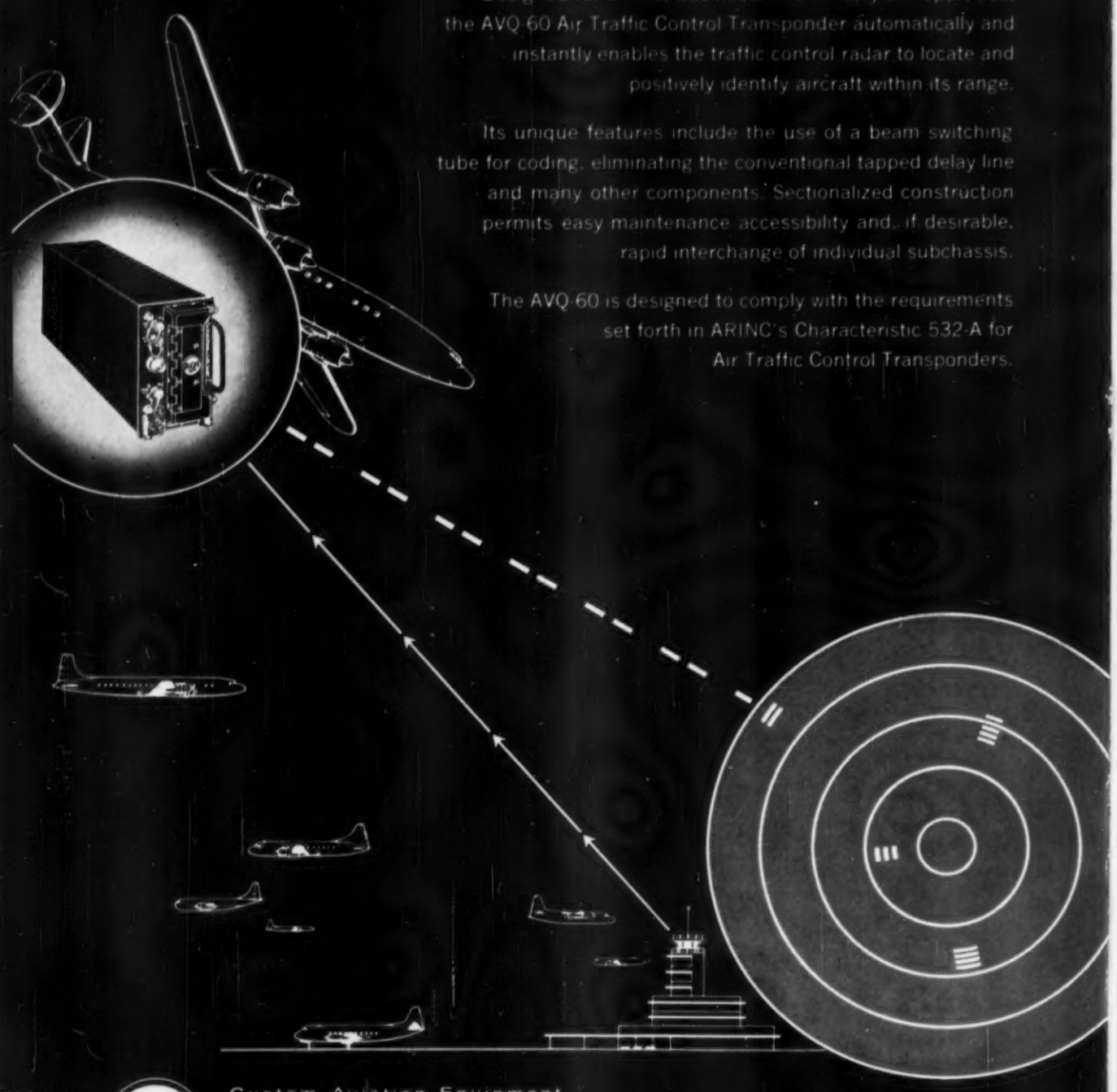

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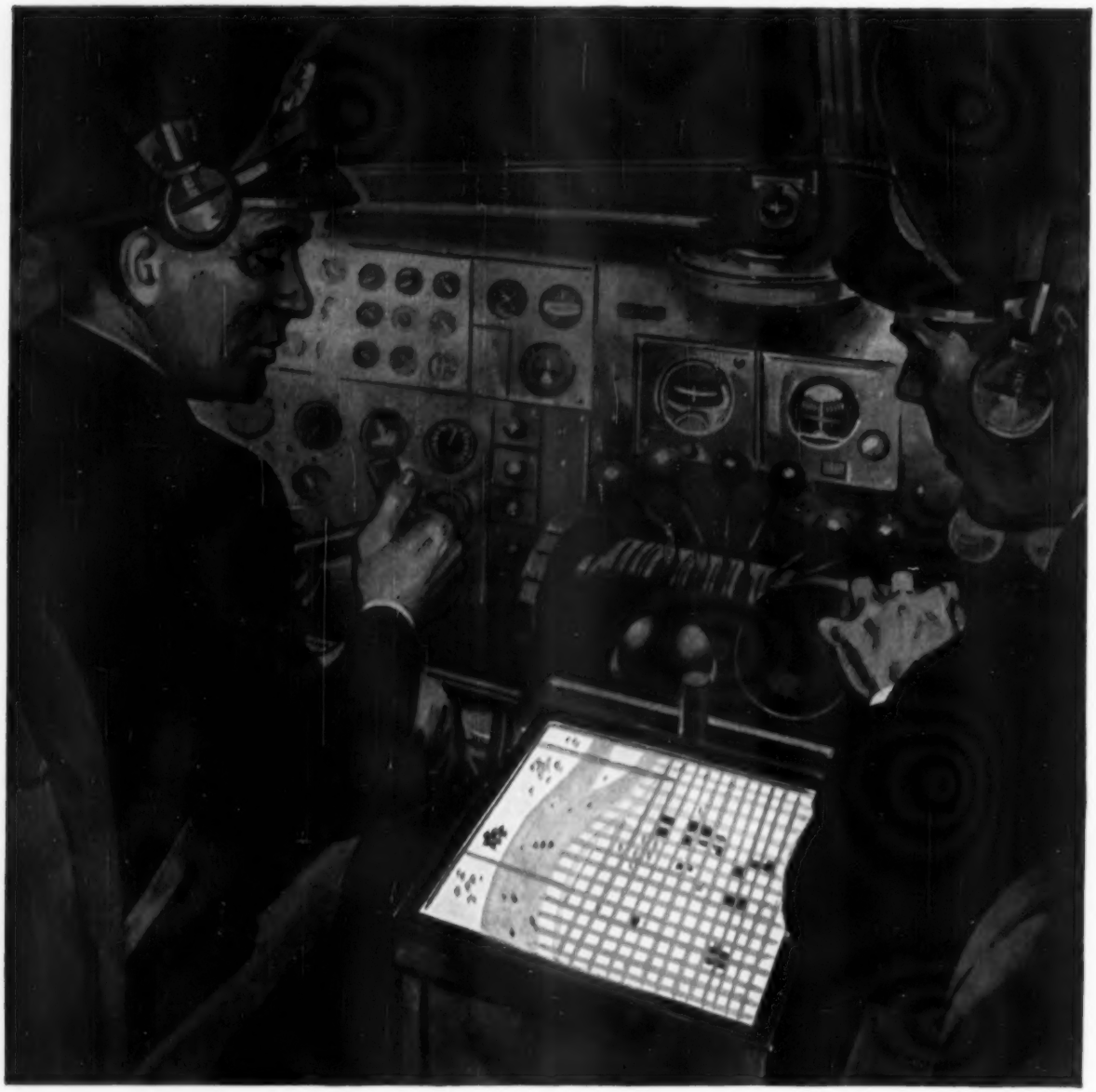

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Autopilot Error in Big Jets Plagued Boeing Engineers

Los Angeles—Unique problem of providing an autopilot for KC-135, B-52 and B-47 multi-jet aircraft necessitated an extensive program with the B-47, a Boeing Airplane Co. engineer told Radio and Technical Commission for Aeronautics and Institute of Radio Engineers members at their recent symposium here.

Application of a good contemporary autopilot to the B-47 in 1949 was unsuccessful and roll, pitch and yaw oscillations defied mathematical analysis, according to J. R. Utterstrom of Boeing's electro-dynamics staff, whose report was among technical papers presented at the symposium.

Another highlight among the presentations was a paper by DeForest L. Trautman of Hughes Aircraft Co. in which he predicted that future aircraft communication will be by automatic data transmission.

Boeing's first experience with the autopilot problem was with the B-47. After initial failure, analog computer programs and flight tests made possible the development of a version that worked.

The dihedral effect of swept wings caused Dutch roll, an aerodynamic coupling between yaw and roll forces. Solution to the problem was to install a rate gyro to detect yaw and supply a damping signal before lateral flow could lift the advanced wing.

Control of pitch oscillation proved to be a somewhat more subtle and complicated task. High frequency oscillations with a period of two to five seconds were found to stem from a number of causes. Too much elevator displacement per deviation from the selected attitude, too little elevator per unit of pitch rate, too much rate gain, lag or non-linearity in the airplane control systems can produce the short period oscillations.

The short period oscillations are all fairly easily compensated but the oscillations with periods from 20 to 200 seconds are more difficult, Utterstrom said. The aerodynamic cleanliness of jet aircraft aggravates the tendency to exchange kinetic and potential energy in a slow phugoid oscillation during which gravity is useless as an absolute pitch reference for erection of the existing gyros.

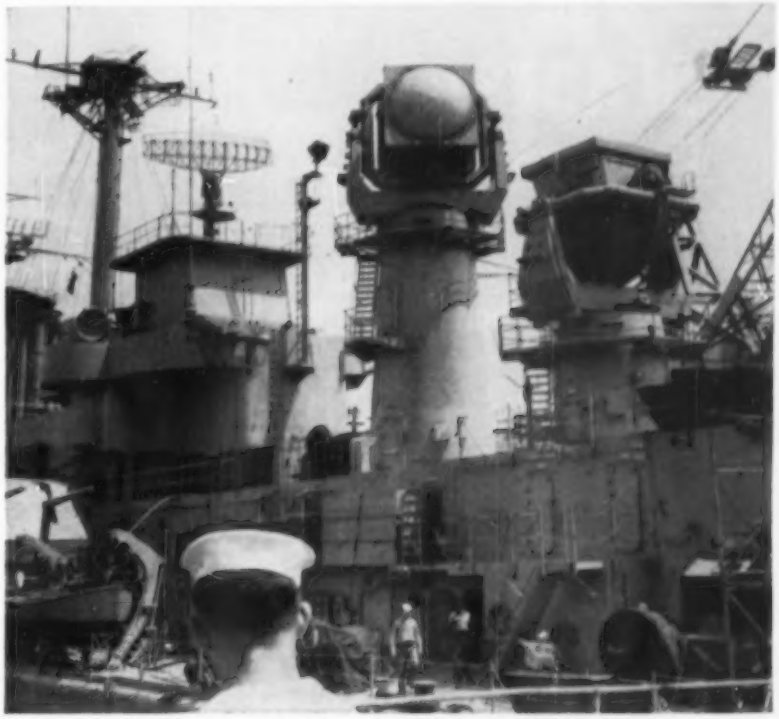
Boeing found that the erection mechanism took effect so rapidly relative to the period of oscillation that it tended to cancel out the error signal. The phugoid oscillation occurs in older, slower aircraft too, but its period is shorter relative to the time constant of the old erection mechanism and there is less opportunity for the tendency of the erection mechanism to stabilize the gyro in an erroneous position to take effect. In a B-47, the 1949 gyro lost 80% of its effectiveness in detecting pitch error.

Answer to the problem was a gyro with less effective erection and less drift to compensate for slower erection.

The 1949 gyros had erection gradients as steep as 20 deg. per min. per deg. of apparent vertical error. Present gyros have gradients between three and five deg. per min. per deg.

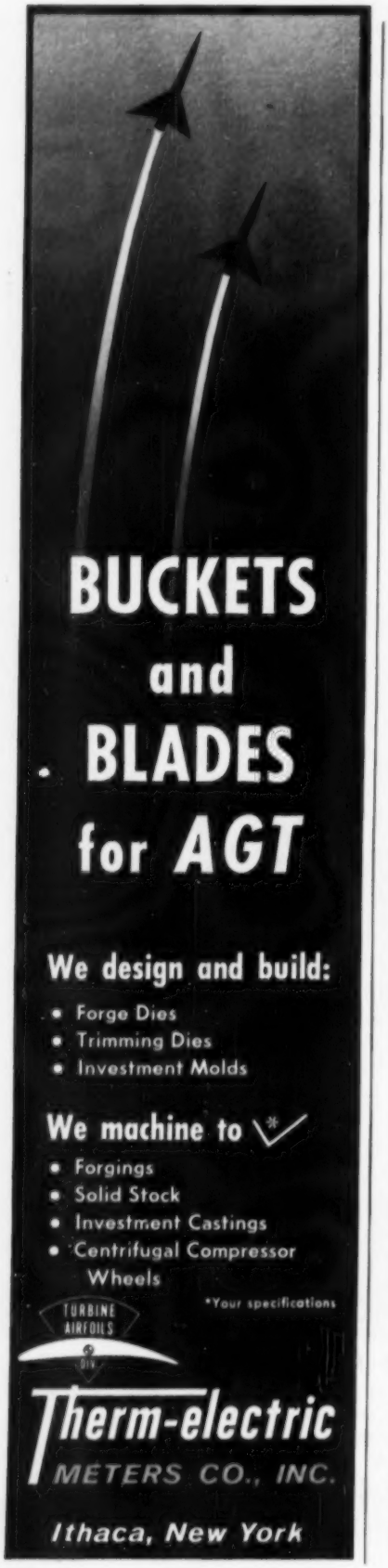
Among the yaw-roll oscillations which harassed autopilot designers for the big jets was a tendency to snake slightly without departing very far from heading. Main reason for this was determined to be the use of rudder to hold the selected heading. Rudder was found to be a poor control for this purpose. It now receives only a rate signal.

Autopilot controlled turns were found to be a source of difficulty. The airplanes tended to roll out off course, make a badly coordinated heading shift after roll-out, suffer from transient bad coordination at intercardinal headings, shallow out of the bank during the turn and roll out with the outside wing low. The first three problems were caused by the error in the directional gyro induced by the angle of bank. Solution was to declutch the gyro at the beginning of the turn and re-engage it after roll-out. Bank shallowing and the top-wing-low roll-out were more difficult to understand as the roll erection was always disengaged. It was found



Super Radars Guide Terriers

First photo of two high power radars, housed in turret-like structures (center, right) aboard U.S.S. Canberra, show units used to guide Terrier anti-aircraft missiles. Either of the two AN/SPQ-5 radars, produced by Sperry Gyroscope Co., can direct single launcher or battery of missile launchers. Sperry says radar systems "include flexible modes of scanning air space many miles beyond the horizon, providing advantage of early warning." This suggests use of airborne radar-relay aircraft. Two cruisers, U.S.S. Canberra and Boston, have already been converted to use Terriers; the Topeka, Providence and Springfield are now undergoing conversion.



Symposium Coverage

Coverage of the Spring, 1957 symposium of the Radio Technical Commission for Aeronautics and the Institute of Radio Engineers was accomplished by Richard Sweeney and Russell Hawkes of Aviation Week's West Coast bureau.

that a pitch acceleration was being detected by the pitch erection sensor which was converted to a roll signal in the course of a 90 deg. turn. Situation was cured by cutting out roll erection during a turn.

The autopilot is made more useful by coupling it to instrument landing systems and navigation aids such as VOR but this produces its own problems. Following a VOR radial is quite easy for an autopilot even during a strong cross wind by use of error integration techniques. It becomes more difficult while flying through the cone of ambiguity over the station. To prevent bracketing, some type of clamping circuit is necessary which can detect the edge of the cone and freeze the airplane on its course. There is the task of avoiding nuisance clamps caused by beam noise and irregularity of cone characteristics.

Structual Coupling

A problem more or less peculiar to the big jets is that of structural coupling due to the elasticity of the airframe. For instance, local motion can cause the yaw rate gyro to pick up a false error signal or one that is out of phase with the actual error. The most effective technique against this is to restrict the pass band of the autopilot to those frequencies which could not possibly couple with the natural frequencies of the airplane structure. Fortunately, this leaves adequate control capability for current airplanes.

Of future aircraft communication, Trautman said many aircraft will carry common voice and digital data equipment to claim advantages of both methods. Proponents of voice communications defend the method on grounds that it permits more flexible message structure and provides closed loop operation in which the pilot always knows whether his incoming message is garbled and knows that his own message is understood if the receiver acknowledges.

Disadvantages pointed out by advocates of digital communications are wide bandwidth and difficulty of integrating voice airborne link into a single ground network which is rapidly becoming necessary to air traffic control. Present non-automatic relay of flight plan and traffic control data causes delays which cannot be accepted as traffic speeds rise. Trautman said a worldwide network providing quick transmission of traffic control numerical data is an eventual certainty.

Trautman's paper was concerned mainly with long-range communication, but he pointed out that much air traffic control can be handled within line-of-sight. Radio line-of-sight range for a jet transport cruising above the 20,000-ft. penetration altitude is about 200 mi., he said. Operational functions formerly handled by a ground net or en route are now being concentrated in dispatch centers at route terminals. Over a million contacts per month are now being handled in the five megacycle wide VHF band.

Three Categories

Trautman breaks communication outside of line of sight into three long range categories—transhorizon, 200 to 500 mi; medium, 500 to 1,200 mi; and global, more than 1,200 mi. All three long range categories suffer from unreliability stemming from a number of causes. Sources of unreliability in the communications "path" and "package" are influenced by speed and size of the aircraft.

Received signals vary in strength and time relationships. Strength is a function of the spreading of the transmitted wave, absorption en route and reflectivity of the medium which redirects the signal to the receiver.

Time variations arise from the vector composition of a signal arriving by various paths.

Tropospheric scattered fields in the

Aviation Week Series Called Infrared Spur

Los Angeles—Airline interest in infrared as a possible solution to the proximity warning indicator dilemma was stirred by Aviation Week's series on infrared, an Air Transport Association spokesman told Radio Technical Commission for Aeronautics and Institute of Radio Engineers members at their symposium here.

"Whereas we have been pressing for a self-sufficient PWI for over two years, it was not until Phil Klass wrote his excellent series of articles on infrared in Aviation Week, and we sent out personal invitations to the infrared experts, that we got the infrared pot boiling," Frank C. White told the engineers.

In a paper delivered at the meeting, White also said several "very interesting proposals" were made at a recent meeting of airlines, ATA and companies concerned with infrared development. The ATA spokesman said a system could be in flight status within a year if a manufacturer puts the necessary effort into developing it.

HOW CONVAIR PUT THE HEX ON HEAT

Hexcel glass-fabric honeycomb—long noted for its rigidity and excellent dielectric qualities—has a new use in Convair's B-58 Hustler. Heat resistant glass-fabric honeycomb—sandwiched between conventional metal skins—gave the Hustler's designers two big advantages in combatting heat in primary structures. **1**-Hexcel glass-fabric honeycomb core reduces internal temperature by as much as 40°. **2**-The glass-fabric sandwich presents a smooth surface for less air-friction...less heat. And, of course, the reduction in parts, (rivets, wing bracings, etc.), and improved structural efficiency through Hexcel Honeycomb sandwich construction saved thousands of pounds in the total weight of the plane. New shapes and new ideas in honeycomb sandwich construction—the result of engineering and research cooperation between Hexcel Products Inc., and Convair—contributed to the success of the Hustler. Hexcel's laboratories and sales-engineers are at the aircraft industry's immediate service.

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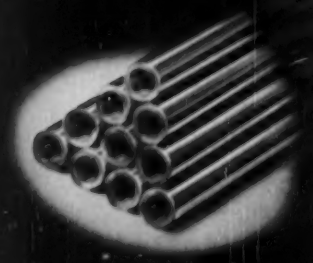

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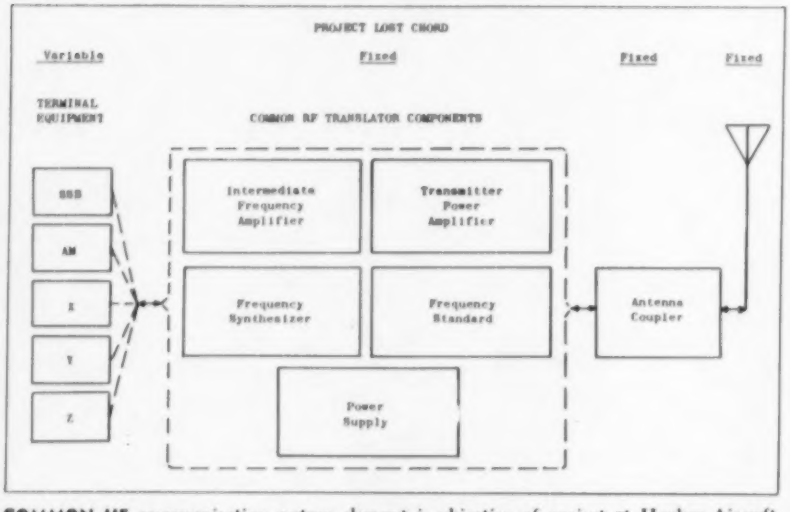
transhorizon range are 70 to 100 db below the signal attenuated only by wave spreading, called "free space loss." The signal is highly reliable.

Ionospheric scattering can approach free-space strengths at all ranges, especially global. They are, however, unreliable, particularly in auroral regions.

Efforts now are being made to apply scatter techniques to airborne communications. Price of better reliability will be higher power requirements and difficult antenna designs. As equipment and propagation reliability increase, message form assumes greater significance as a factor in efficiency of communication. Because of this, form will be more important in minimizing interference.



COMMON HF communication system element is objective of project at Hughes Aircraft.

Standardized Circuits Sought For Airborne Communications

Dayton, Ohio—Program aimed at cutting the time and cost of designing new high-frequency airborne communication systems, reducing obsolescence and easing maintenance problems has been launched by Wright Air Development Center's Communication and Navigation Laboratory.

The program, called Project Lost Chord, also marks the entry of Hughes Aircraft Co. into the airborne communications field.

The concept behind Project Lost Chord is to develop a family of basic standardized circuits that can handle all present and contemplated future types of modulation. George H. Scheer, chief of the WADC Communications Branch, calls these basic circuits "common RF translator components."

Items Included

In the case of a transmitter they would include such items as: frequency standard, frequency synthesizer, power amplifier, intermediate frequency amplifier and power supply. These could be used with any desired terminal equipment (see sketch) to provide conventional AM, synchronous detection, suppressed-carrier single sideband, compatible single sideband, radio teletype, digital communications, or other, Scheer says. When new modulation methods are developed it would only be necessary to design new terminal equipments, Scheer believes.

By using this approach it should be possible to switch an airplane's HF communications quickly from SSB to AM, or any other desired mode of operation, merely by substituting new terminal equipment, Scheer says.

Modular Construction

Each of the common RF translator components would be produced in modular form in order to permit flexible form factor. This is similar to philosophies now in use in other USAF and Navy avionics equipment.

The components which Hughes is developing, in connection with another project, include a 1 kw power amplifier with linearity sufficient to permit SSB operation. Scheer says that Hughes expects to deliver its Lost Chord components around mid-1958.

If the program objective can be achieved, and Scheer believes it can, it should provide major economies. For example large quantities of the stand-

ardized modules can be obtained from multiple sources. Logistics and maintenance problems in HF communications would be eased. Furthermore, all-out efforts could be justified to make the common translator components extremely reliable since they would be expected to enjoy considerable longevity without obsolescence.

Expansions, Changes In Avionics Industry

General Electric has moved to integrate its airborne avionics activities under one departmental roof by merging its Aircraft Products Dept., Johnson City, N. Y., into its Light Military Electronic Equipment Dept. (LMEED), Utica, N. Y. The move will combine GE's bomber defense activities in a single department.

The former department moves down one notch in GE's organizational structure to become the Armament and Control section of LMEED. Another group at Coxsackie, N. Y., formerly part of APD, becomes the Specialty Heating Products section of LMEED. M. R. Johnson, former manager of engineering at LMEED has been named manager of the new Johnson City operation. GE says the recent move will not result in appreciable transfer of personnel.

Other recently announced changes and expansions in the avionics industry include:

• **Dynamics Instrumentation Co.,** South Pasadena, Calif., maker of electronic instrumentation systems, has been acquired by Alberhill Corp. and will operate as a division of the latter, maintaining its present name and location. George W. Downs has been appointed director of the new division.

• **Tripac Scatter Communications, Inc.,** Bethesda, Md., is name of newly formed subsidiary of Tripac Engineering Corp., also of Bethesda. New firm's members are former employes of Page Communications Engineers where they participated in engineering and supervision of installation of USAF's large scatter communications system. Samuel A. Jordan is president of new firm. Address is 4932 St. Elmo Ave.

• **Dynamics Corporation of America,** New York, has acquired Radio Engineering Laboratories Inc. (REL), Long Island City, N. Y., major manufacturer of tropospheric scatter communications and radio equipment. New acquisition will continue operation under present name and same management and personnel as a wholly owned DCA subsidiary.

• **General Electric** has established new facility for testing complete aircraft

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electrical systems at Waynesboro, Va. New laboratory will be operated by personnel from GE's Aviation and Defense Industries Sales Dept., Schenectady, N. Y., and will test electrical system components produced by company's Direct Current Motor and Generator Dept., Erie, Pa., and its Specialty Control Dept. at Waynesboro.

• **Glass-Tite Industries, Inc.,** Johnston, R. I., is name of new manufacturer of hermetic seals. Company address: 1391 Atwood Ave.

• **H. K. Porter Co., Inc.,** New York, has acquired Federal Wire & Cable Co., Ltd., Guelph, Ontario, Canada's fourth largest producer of wire and cable.

• **Digitronics Corp.,** Long Island City, N. Y., is name of new company which will manufacture digital systems and components and serve as consultant in this field. Company's address: 35-10 36th Ave.

• **Narda Corp.,** Mineola, N. Y. producer of microwave equipment, has appointed Gene French Co., 120 San Pedro St., Albuquerque, N. M., as its sales and service representative in New Mexico, Arizona, Colorado and Utah.

• **Sylvania Electric Products, Inc.,** has started construction on new 40,000 sq. ft. facility to house its Missile Systems Laboratory in Waltham, Mass. Completion is scheduled for October.

• **Mincom Division of Minnesota Mining and Manufacturing Co.,** makers of wideband magnetic tape systems, has moved to new quarters at 11701 Mississippi Ave., West Los Angeles, Calif.

• **Microwave Associates, Inc.,** Burlington, Mass., has formed new research and engineering group to develop high power microwave switching devices. Dr. Lawrence Gould heads new group.

• **C. P. Clare & Co.,** Chicago relay and switch maker, has merged with **Universal Products Co.,** New York, to become a wholly-owned subsidiary of the latter firm. C. P. Clare, founder, will continue as president and chairman of the board and also will serve on board of Universal Products.

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FILTER CENTER

▶ **No Slow-Poke**—Computer output printer capable of recording one million characters per minute has been developed by Radiation, Inc., Melbourne, Fla., according to company president Homer R. Denius. Denius also reports a new high speed analog-to-digital data processing system capable of handling 24,000 data samples per second.

▶ **Nose for Trouble**—Raytheon is developing both the bombing and navigational radars to be used in the B-58 Hustler, it reports. Company says it has responsibility for "the forward 10 feet of the Hustler fuselage as well as other sections of the plane."

▶ **Transistor Sales Continue Gain**—Semiconductor manufacturers sold 1.9 million transistors in March, 2.7 times as many as in the previous March, to set a new all-time sales record. Dollar volume for March 1957 was $5.3 million, slightly under last March's figure which reflects lower unit prices. First quarter transistor sales totalled $14.6 million.

▶ **New Business**—New contract awards recently announced by avionics manufacturers include:

• **Mack Electronics Div., Inc.,** Plainfield, N. J., has received $1.6 million USAF contract for high power UHF transmitting equipment.

• **Sperry Gyroscope Co.,** Great Neck, N. Y., reports $3.4 million contract from Air Materiel Command for continued production of its MA-2 automatic flight control systems used on the B-52.

X-13 Test Pilot: Before and After

Contrast between the expressions on the face of Peter F. Girard, Ryan Aeronautical Co. chief test pilot, before first Ryan X-13 Vertijet conversion flight (left), and after (right), tell their own graphic story of the tensions a test pilot is subjected to. Conversion was successful (AW May 13, p. 29).

Army Contracts

Following is a list of unclassified contracts of $25,000 and over as released by Army Contracting Offices:

REDSTONE ARSENAL, Huntsville, Ala.

Arnolt Corp., Warsaw, Ind., item 1, pipe, assy, hydraulic, Y002-1420-8002968, ORD part no. 8002968 (line item 1-4-875), 1520 ea., F.O.B. LaCarne, Ohio; 820 ea., F.O.B. Avondale, Ohio; pipe, assy, hydraulic, 1420-8002806 (Y002), ORD part no. 8002806 (line item 2-7-887), 560 ea., F.O.B. LaCarne, Ohio; 300 ea., F.O.B. Avondale, Colo.; pipe, assy, hydraulic, 1420-800-2969 (Y002), ORD part no. 8002969 (line item 3-81887), 340 ea., F.O.B. LaCarne, Ohio; 220 ea., F.O.B. Avondale, Colo.; pipe, assy, hydraulic, 1420-800-2970 (Y002), ORD part no. 8002970 (line item 4-9-887), 40 ea., F.O.B. LaCarne, Ohio; 200 ea., F.O.B. Avondale, Calif.; pipe, assy, hydraulic, 1420-800-2810 (Y002), ORD part no. 8002810 (line item 5-1-893), 2309 ea., F.O.B. LaCarne, Ohio; 1244 ea., F.O.B. Avondale, Colo.; pipe, assy, hydraulic, 1420-800-2809 (Y002), ORD part no. 8002809 (line item 6-2-903), 572 ea., F.O.B. LaCarne, Ohio; 308 ea., F.O.B. Avondale, Colo., (Purchase Request: RSP-225-57), $38,668.

Clark Cable Corp., 3184 W. 32nd St., Cleveland 9, Ohio, item 1, pipe, assy, hydraulic, 140-8002811 (Y002), ORD part no. 8002811 (line item 1-2-893), 1266 ea., F.O.B. LaCarne, Ohio; 682 ea., F.O.B. Avondale, Colo.; tube, assy, Y002-8161961, ORD part no. 8161961 (line item 2-12-924), 272 ea., F.O.B. LaCarne, Ohio; 146 ea., F.O.B. Avondale, Colo.; pipe, assy, hydraulic, 1420-8002801 (Y002), ORD part No. 800-2801 (line item 7-6-989), 130 ea., F.O.B. LaCarne, Ohio; 70 ea., F.O.B. Avondale, Colo., pipe assy, hydraulic, 1420-8002801 (Y002) ORD part no. 8002801 (line Item 7-6-989), 130 ea., F.O.B. LaCarne, Ohio; 70 ea., F.O.B. Avondale, Colo.; (Purchase Request: RSP-230-57), $29,100.

Spinecraft, Inc., 4122 W. State St., Milwaukee, Wis., item 1, head, inert, 762 millimeter rocket, T2037, fabricated and packaged in accord with ORD Corps dwg F-8026305, Rev G and marking according to ORD corps dwg F-8026438, Rev B, 12 ea., F.O.B. Las Cruces, N. Mex., head, inert, 762 millimeter rocket, T2037 fabricated and packaged in accordance with ORD Corps dwg F-8026305, Rev G and marking according to ORD Corps dwg F-8026438, Rev B, 279 ea., F.O.B. Carrier's Equipment or freight station nearest contractor's plant at: Milwaukee, Wis., (Purchase Request: IDR-R-57-5), $33,198.

Westinghouse Electric Corp., 210 E. Sixth St., Charlotte, N. C., item 1, sheet, Westinghouse grade 259-2 glass melamine micarta to spec MIL-P-15037-B, grade GMG, in the following sizes: 1.3" thick x 48" x 48" (12 sheets), 5814 lb., 2.3" thick x 36" x 72" (22 sheets), 12012 lb., 3.3" thick x 36" x 36" (12 sheets), 3276 lb. (Purchase Request: ME-14056-57 and ME-14311-57), $46,869.

E. I. Dupont De Nemours & Co., Inc., Peroxygen Products Div., Electrochemical Dept., Wilmington 98, Del., item 3, hydrogen peroxide, 90% C.P. grade (in 30 gal. alum. drums-returnable) (250 lb. drums), 26250 lb., hydrogen peroxide, 76%, 26250 lb., deposit for 250 lb alum. drums, 210 ea., (Purchase Request: ME-16029-57), $29,859.

Arnolt Corp., Warsaw, Ind., item 1, screw, Y002-8176350, ORD part No. 8176-350 (line item no. 1-21-379), 1700 ea., F.O.B. LaCarne, Ohio; 900 ea., F.O.B. Avondale, Colo., retainer, 1420-049-7226 (Y002) ORD part No. 8006121 (line item no. 2-3-907), 160 ea., F.O.B. LaCarne, Ohio; 100 ea., F.O.B. Avondale, Colo.; bolt, 5305-8175045 (Y002) ORD Part No. 8175045 (line item No. 3-4-929), 300 ea., F.O.B. LaCarne, Ohio; 200 ea., F.O.B. Avondale, Colo.; washer, 5310-5688610 (Y002) ORD part no. 8024519 (line item No. 4-4960), 800 ea., F.O.B. LaCarne, Ohio; 450 ea., F.O.B. Avondale, Colo.; screw, Y002-8024826, ORD Part No. 8024826 (line item No. 5-12-966), 7000 ea., F.O.B. LaCarne, Ohio; 3300 ea., F.O.B. Avondale, Colo.; bolt, Y002-8024789, ORD part no. 8024789 (line item no. 6-1-967), 1100 ea., F.O.B. LaCarne, Ohio; 600 ea., F.O.B. Avondale, Colo.; housing 6615-8001030 (Y002) ORD part no. 8001030 (line item No. 7-1-971), 175 ea., F.O.B., LaCarne, Ohio; 94 ea., F.O.B. Avondale, Colo.; setscrew, 5305-817-5049 (Y002) ORD part no. 8175049 (line item No. 8-1-986), 300 ea., F.O.B. LaCarne, Ohio; 200 ea., F.O.B. Avondale, Colo.; washer, flat, 5310-801-4684 (Y018), ORD part no. 8014684 (line item no. 9-2-986), 800 ea., F.O.B. LaCarne, Ohio; 500 ea., F.O.B. Avondale, Colo.; cover voltage safety, 1420-0985876 (Y002), ORD part no. 802-0706 (line item No. 10-1-989), 2100 ea., F.O.B. LaCarne, Ohio; 1200 ea., F.O.B. Avondale, Colo.; clip hydraulic line 5340-388-9648 (Y013), ORD part no. 8014781 (line Item No. 11-1-1018), 800 ea., F.O.B. LaCarne, Ohio; 400 ea., F.O.B. Avondale, Colo.; screw, Y00-25305-1456880, ORD part no. 1511382 (line item no. 12-3-988), 9000 ea., F.O.B. LaCarne, Ohio; 6000 ea., F.O.B. Avondale, Colo.; bolt, 5306-6992763 (Y027), ORD part no. 8515458 (line item 13-1-840), 260 ea., F.O.B. LaCarne, Ohio; 140 ea., F.O.B. Avondale, Colo.; (Purchase Request: RSP-216-57), $45,212.

Hayes Aircraft Corp., P.O. Box 2287, Birmingham, Ala., item 5d, additional estimated 13040 manhours of engineering services, 1 job, (Purchase request: CS-5803-56 10D-991-57. GML-148-56), $81,500.

PHILADELPHIA ORDNANCE DIST., 128 N. Broad St., Philadelphia, Pa.

Western Electric Co., Burlington, N. C., Nike spare parts & components, $26,853.

Western Electric Co., Burlington, N. C. Nike spare parts & components, $26,969.

LOS ANGELES ORDNANCE DIST., 55 S. Grand Ave., Pasadena, Calif.

Firestone Tire & Rubber Co., 2525 Firestone Blvd., Los Angeles 54, Calif., container, shipping aft section missile body, X88M-A-17, job, $71,292.

Douglas Aircraft Co., Inc., 3000 Ocean Park Blvd., Santa Monica, Calif., Nike replenishment spare parts, job, $35,714.

CORPS OF ENGINEERS, Fort Worth Dist., P. O. Box 1600, Fort Worth, Tex.

Texas Bitulithic Co., 2121 Irving Blvd., P.O. Box 10365, Dallas, Tex., construction of runway extensions, Majors Field, Greenville, Tex., (Contract No. 4941) (Inv. No. ENG-41-443-57-29), job, $332,918, (base bid plus additive alternates "A" and "B").

H. B. Zachry Co., P. O. Box 10188, San Antonio, Tex., construction of apron runway, and taxiway paving and refueling facilities, Bergstron AFB, Austin, Tex., (Contract No. DA-41-443-eng-4942) (Inv. No. ENG-41-443-57-25), job, $9,105,943, (Sched I).

RESEARCH CONTRACTING DIV., Transportation Research Engineering Command, Fort Eustis, Va.

Convertawings, Inc., Amityville, N. Y., a development program investigating the four-rotor helicopter concept, contract DA 44-177-TC-411, job, $88,910.

CORPS OF ENGINEERS, Jacksonville, Dist., 575 Riverside Ave., Jacksonville, Fla.

Paul Hardeman, Inc., (J. B. Gill Div.), 11558 Tenn. Ave., Los Angeles 64, Calif., furnishing helium purifiers for compressor bldgs. 15 and 19, Cape Canaveral Auxiliary AFB, Fla., job, (ENG-08-123-(NEG-57-49), $37,700.

Cleveland Electric Co., Inc., P.O. Box 5721, Jacksonville, Fla., construction of electrical switching station and distribution, Air Force Missile Test Center, Patrick AFB, Fla., job, (ENG-08-123-(NEG-57-47), $119,977.

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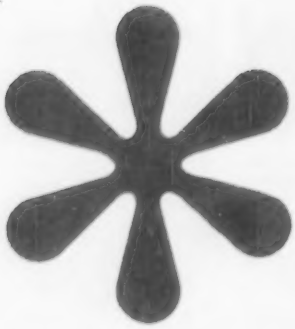

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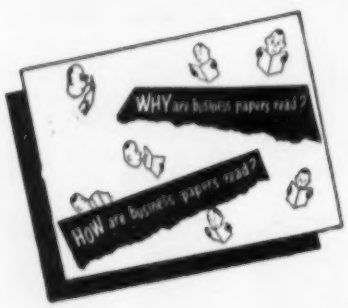

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Navy Contracts

Following is a list of unclassified contracts for $25,000 and over, as released by Navy Contracting Offices:

AVIATION SUPPLY OFFICE, 700 Robbins Ave., Philadelphia 11, Pa.

Kollsman Instrument Corp., 80-08 45th Ave., Elmhurst 73, N. Y., tachometer indicators: (PREN-11-1311/57), various, $187,604.

Scintilla Div., Bendix Aviation Corp., Sherman Ave., Sidney, N. Y., maintenance parts for ignition & harness assys, (383/2118-55/55), various, $76,332.

Regent Jack Mfg. Co., Inc., 11950 Regentview Ave., Downey, Calif., axle and axle-hydraulic jacks, (JD-IFB-383-1077-57), various, $68,318.

Switlik Parachute Co., Inc., 1325 E. State St., Trenton, N. J., vest life preservers, (383/29045-67G3/1, 5/57), 12000 ea., $282,000.

Scintilla Div., Bendix Aviation Corp., Sherman Ave., Sidney, N. Y., maintenance parts for ignition units, (383/2118-182/53), various, $621,391.

Belleville Shoe Mfg. Co., Main & Walnut Sts., Belleville, Ill., leather flightdeck shoes, (JD-IFB-383/1667-57), various $53,812.

Radio Corp. of America, West Coast Electronics Products Dept., 11819 W. Olympic Blvd., Los Angeles 64, Calif., emergency radio sets, (383/29031-26-E1/3/57), various, $103,607.

Pioneer Central Div., Bendix Aviation Corp., 2600-2800 Hickory Grove Rd., Davenport, Iowa., accelerometers, (PREN11-1244/57), various, $282,693.

Grumman Aircraft Engineering Corp., Bethpage, L. I., N. Y., cylinder assys, (CG667-57-40), various, $42,567.

Pioneer Central Div., Bendix Aviation Corp., Davenport, Iowa, fuel flowmeter transmitters, (PREN11-1257-57 & Change A), various, $126,591.

Scintilla Div., Bendix Aviation Corp., Sherman Ave., Sidney, N. Y., maintenance parts to support ignition units, (383/2118-5020/55, 383/9504-79/57), various, $136,-999.

BUREAU OF ORDNANCE, Washington, D. C.

E. I. DuPont de Nemours & Co., Inc., Wilmington, Del., hydrogen peroxide (Navol) NOrd-17569, prop. no. NOrd-114-57, 400,000 lb., $146,000.

Yardney Electric Corp., torpedo batteries (silver cell) Mk 42 mod 0, MIL-B-17348, NOrd 17527, 265, $257,845.

Western Electric Co., N. Y., N. Y., guidance control evaluation equipment, NOrd-17468, $27,774.

Lansdowne Steel & Iron Co., Morton, Pa., 3"/50 AA projectile, Mk 33 mod 0, NOrd-17583, prop no. NOrd-94-57, 120,000, $662,-400.

Ganary Bros., Mt. Ephraim, N. J., 3"/50 AA projectiles, Mk 33 mod O, NArd-17584, prop no. NOrd-94-57, 120,000, $647,160.

Aerojet-General Corp., Sacramento, Calif., 22630 rockets, JATO aircraft, solid propellant 15KS 1000 and igniters and 1132 spare igniters, NOrd-17467, prop no. 138-56, $3,548,862.

BUREAU OF SHIPS, Washington 25, D. C.

Bethlehem Pacific Coast Steel Corp., 20th & Illinois St., San Francisco, Calif., repair, activation and conversion of the USS Oklahoma City (CL91) to a light cruiser-guided missile CLG91 (Talos) and preparation of detail working plans, (Contract NObs-3906 (Inv. No. 523-29Q), 1 ea., $1,400,000.

Bethlehem Steel Co., Shipbuilding Div., Quincy, Mass., repair, activation and conversion of the USS Springfield (CL66) to a light cruiser-guided missile CLG66 (Terrier) and preparation of detail working plans, (Contract NObs-3907 (Inv. No. 523-31Q), 1 ea., $14,000,000.

PUBLIC WORKS OFFICER, Eighth Naval Dist., New Orleans, La.

J. M. Dellinger, Inc., P. O. Box 4227, Corpus Christi, Tex., construct crosswind runway and taxiway, Naval Auxiliary Landing Field, Alice-Orange Grove, Tex., (IFB NBy 1168), $1,787,000.

T. L. James & Co., Inc., P. O. Box 531, Ruston, La., runway, taxiway and apron paving, Naval Auxiliary Air Station, New Iberia, La., (IFB NBy-6394), $8,775,600.

H. & Y. Construction Co., Inc., 2500 Federal St., El Paso, Tex., FPS-8 building, Naval Ordnance Missile Test Facility, White Sands Proving Ground, N. Mex., (IFB NBy-9091), $22,446.

BUREAU OF AERONAUTICS, Washington 25, D. C.

General Motors Corp. (Allison Div.), Indianapolis 6, Ind., modernization and restoration of T40 engines, (IFB MA-44-4388-57), $7,776,611.

AMC Contracts

Wright-Paterson AFB, Ohio—Following is a list of unclassified contracts as released by the Air Materiel Command.

Minneapolis-Honeywell Regulator Co., Aeronautical Div., 2600 Ridgeway Ave., Minneapolis, Minn., MA-2 low altitude bombing system, spare components, spare parts, (PR 630959), $415,312.

Edgerton, Germeshausen and Grier, Inc., 160 Brookline Ave., Boston, Mass., service test AN/ASH-6 recording seet for B-52 and B-47 bomber, spare parts for item 1, special tools and test equipment, (PR 604392 and 604392-1), $442,765.

General Electric Co., 1000 Western Ave., West Lynn, Mass., electrical tachometer indicator required for H23A and B acft, (MIPR R56-8709-TSMC-05D), $31,918.

The Electric Auto-Lite Co., P. O. Box 931, 1201 Champlain St., Toledo 1, Ohio, gages, pressure dial indicating, hydraulic type E-6, spare parts and data, (PR 603-638), $44,872.

E. I. du Pont de Nemours and Co. Inc., Wilmington 98, Del., squib, electric, 4 grain, squib, electric, 15 grain, squib, electric 8 grain, ammunition program, (PR SA-675-085), $50,802.

Cook Electric Co., 2700 Southport Ave., Chicago, Ill., relay assys, inverter changeover, type B-1, (application: B-47, F-89, B-57E and C-124C acft), (PR SA-639727 and 639728), $217,322.

NARC Co., Inc., 824 S. Western Ave., Chicago 12, Ill., light, photographic, copying arc, type B-6, technical data, engineering data, (PR MO-725905 and MO-735-905-1), $29,183.

Lear, Inc., Lear-Romec, Inc., Abbe Rd., Elyria, Ohio, pump, pressure, oil-free air-acft, (PR PE-635720, PE-604322 and SA-611069), $128,055.

The Goodyear Tire & Rubber Co., 1144 E. Market St., Akron 16, Ohio, wheel assys, F-84 acft, brake assys, F-84 acft, wheel assys, T-28 acft, (PR 00-787009), $285,916.

United Aircraft Corp., Hamilton-Standard Div., Windsor Locks, Conn., starters, pneumatic, acft engine, (PR PE-604319), $80,-191.

The Leland Electric Co., Div. of American Machine & Foundry Co., 1501 Webster St., Dayton, Ohio, motor generators, 1500 VA, type BM-3 for support of F-86, F-100A, C119, C-123 and C-124 acft, (PR SA729419 and PE-694465), $179,417.

Fairchild Camera & Instrument Corp., Robbins Lane, Syossett, Long Island, N. Y., rapidyne shutter assys, 3¼", model H, (PR MO-736428), $40,769.

North American Philips Co., 750 S. Fulton Ave., Mt. Vernon, N. Y., amplifier, used with radio compass, tuning drive, used with radio compass, mounting, used with radio compass, (PR 670946), $44,759.

The Magnavox Co., Fort Wayne 4, Ind., fuse for rocket, acft for service test, (PR 00-555161-2), $26,500.

Lear, Inc., Lear-Romec Div., Abbe Rd., Elyria, Ohio, control-pressurizing type C1173/ASQ, switch, pressure type SA-377/ASQ, (PR PE-63519, PE-635721 and PE-604323), $40,320.

Viewlex, Inc., 35-01 Queens Blvd., Long Island City 1, N. Y., A-9B magazines,

photographic equipment, (PR EC-A-564681 and MO-736384), $228,690.

Cathedral Films, Inc., 140 N. Hollywood Way, Burbank, Calif., 16 mm color motion picture prints, (PR PM-7-PP-5066), $53,000.

Continental Motors Corp., 205 Market St., Muskegon, Mich., engines, packette, model PE 200-2 Spec 11 and 20 (spares), spare parts, engineering data, (PR MP-623203-1 and -2, MP-623998), $843,303.

Continental Motors Corp., 200 Market St., Muskegon, Mich., engines, packette, model, PE 80-2, spec 13, model PE 150-2, spec 11 and model PE 200-2, spec 7, (PR MP-626718 and MP-626718-1), $869,512.

Hayes Aircraft Corp., Birmingham, Ala., KB-50 modification, increase in funds allotment, (PR OC-732805), $2,500,000.

Bendix Aviation Corp., Pioneer-Central Div., Davenport, Iowa, transmitter, rate of flow, fuel, type J-5 used on 737-A, PR603675, $87,082.

Airborne Accessories Corp., 1414 Chestnut Ave., Hillside 5, N. J., actuator assy, data, for H-21A, B and C acft, (PR SA-639655), $28,913.

Grand Rapids Div., Lear, Inc., 110 Ionia Ave., N.W., Grand Rapids 2, Mich., actuator assy, data for SA-16A, SC-47A, SC-47D acft, (PR SA-715411), $41,856.

Bendix Aviation Corp., Bendix Products Div., 401 Bendix Dr., South Bend 20, Ind., wheel assys, 30x8.8, for F-106A and B aircraft, brake assys, 12¼", 4 rotor, F-106A and B aircraft, (PR PE-564272), $558,678.

General Electric Co., X-Ray Dept., 4855 Electric Ave., Milwaukee, Wis., C-7 bodies C-11 magazines, M-2 controls for 0-32 camera system, (PR EC-A 56461, 564642 and 564644), $831,208.

Avco Mfg. Corp., Lycoming Div., 652 Oliver St., Williamsport, Pa., 0-435-23A acft engines, (PR 565144), $896,535.

USAF Contracts

Following is a list of unclassified contracts for $25,000 and over as released by Air Force Contracting Offices:

WARNER ROBINS AMA, USAF, Robins AFB, Ga.

Curtiss-Wright Corp., Caldwell, N. J., repair and/or modification of propeller assys and spare blades, models C 6348-C and C 7355-A, (two contracts), $597,300 and $369,110.

Airtron, Inc., 1101 W. Elizabeth Ave., Linden, N. J., waveguide elbows applicable to E4, E5 & E6 FCS (PR-738629), 2440 ea., $45,994.

General Electric Co., 600 Main St., Johnson City, N. Y., modification kits applicable to A-5 FCS, (PR-433573), $32,-001.

Farrand Optical Co., Bronx Blvd. & E. 238th St., N. Y. 70, N. Y., modification kits for Y-7 bombsight, (PR-693454 & 693455), $61,782.

Republic Aviation Corp., Farmingdale, L. I., N. Y., post assys applicable to F-84 acft, (PR-634030), $199,777.

Curtiss-Wright Corp., Caldwell, N. J., repair, modification, test and storage propeller assys, (PR 735242), $186,797.

D-K Products, Inc., 1056 So. Gerhart Ave., Los Angeles 22, Calif., hammer, pneumatic riveting, slow hitting, (IFB-342), 1160 ea., $40,600.

Heyer Products Co., 471 Cortlandt St., Belleville 9, N. J., rectifier, metallic, portable, type F-1, (IFB-373), 171 ea., $44,289.

Practical Mfg. Co., 2840 S. 4th Ave., Minneapolis 8, Minn., machine-cleaning aircraft oil tank, 71 ea., (IFB-362), $45,085.

Motorola, Inc., 2710 N. Clybourne Ave., Chicago 14, Ill., modification kits applicable to AN/APS-23 (PR-739348, etc), $198,708.

The Flagler Corp., 19321 Filer Ave., Detroit 34, Mich., bending & forming machines, 25 ea., (IFB-390), $36,025.

Lear, Inc., 110 Ionia Ave., N.W. Grand Rapids 2, Mich., installation of autopilot, $34,062.

Cook Electric Co., 2700 N. Southport Ave., Chicago 14, Ill., radar spare parts, $41,244.

Packaging Industries Ltd., Inc., 151 Pine St., Montclair, N. J., heating sealing machines, type 1, size 6, 163 ea., type 3, size 12, 3 ea., (IFB-338), $80,032.

Stromberg-Carlson Co., 1700 University Ave., Rochester, N. Y., end instruments for intercommunication system, (PR-15547), etc), $45,226.

Glenn L. Martin Co., Baltimore 3, Md., engineering and prototype applicable to B-57 acft, (PR-735101 & 734598), $550,000.

Glenn L. Martin Co., Baltimore 3, Md., modification kits for B-57 aircraft, $38,892 and $57,618.

TOPEKA AF DEPOT, Topeka AF Station, Topeka, Kans.

The Delron Co., Inc., 5224 Southern Ave., South Gate, Calif., stainless steel nut, 86,600 ea., (RFP 14-604-57-5351), $25,799.

The Kansas Power & Light Co., 808 Kansas Ave., Topeka, Kans., electric services for Topeka AF Depot and Forbes AFB, Topeka, Kansas, 2059400 KWH, 5284 KVA, (Basic contract AF 14 (603)-90), $26,109.

Cities Service Gas Co., First National Bldg., Oklahoma City 1, Okla., gas service for Topeka AF Depot and Forbes AFB, Topeka, Kans., 141410 MCF, (basic contract AF 14 (603-132), $30,339.

CAMBRIDGE RESEARCH CENTER, ARDC, USAF, Bedford, Mass., Laurence G. Hanscom Field.

Rensselaer Polytechnic Institute, Troy, New York, research directed toward methods for conversion of upper atmospheric energy into useful work, (AF 19(604)2265), job, $45,292.

General Kinetics Inc., 555-23rd St., S., Arlington, Va., digital computer programmer and terminal equipment logical design services, (AF19(604)-2241), job, $49,754.

Weather Services, Inc., 200 Berkeley St., Boston, Mass., research directed toward the eventual elimination or suppression of visible aircraft exhaust trails, (AF 19(604)-1961), job, $33,445.

The John Hopkins University, 34th & Charles St., Baltimore, Md., research di-

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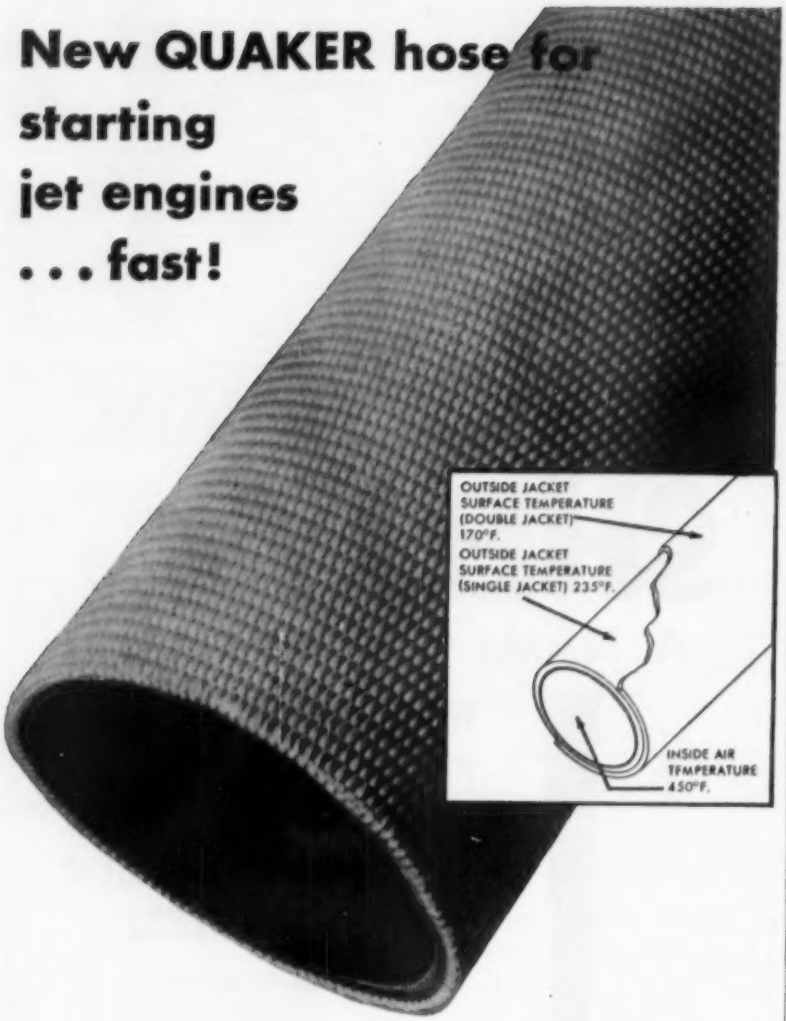
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rected toward the study of far-infrared radiations flux, IFB AF19(604)-2238), job, $25,574.

Sylvania Elec. Products, Inc., P. O. Box 1296, Mountain View, Calif., investigation of an electronically controllable gas phenomena, (IFB AF19(604)-2231), job, $49,684.

Bendix Aviation Corp., Pacific Div., 11600 Sherman Way, North Hollywood, Calif., research directed toward a study to determine feasibility of constructing a 3 to 7 subchannel telemetering canister, (IFB AF19 (604)-2151), job, $39,019.

AIR FORCE MISSILE TEST CENTER, ARDC, USAF, Patrick AFB, Fla.

Radiation, Inc., Melbourne, Fla., modification of technical requirements to include refinement of design and operations, (P. R. 57-1104, 57-1227), job, $104,888.

SAN ANTONIO R&D PROCUREMENT OFFICE, ARDC, P. O. Box 63, Lackland AFB, San Antonio, Tex.

Educational Research Corp., 10 Craigie St., Cambridge 38, Mass., additional work, time and funds on personnel and training research on SAGE (Contract AF41 (657)-95), job, $60,000.

The University of Texas, Austin, Tex., research and reports on effects of ionizing radiation upon physical and psychological functions on various speices, (Contract AF 41(657)-149), job, $63,982.

SAN ANTONIO AMA, USAF, Kelly AFB, Tex.

Pratt & Whitney Co., Inc., Chandler Evans Div., Charter Oak Blvd., West Hartford 1, Conn., repair and modification of 320 ea., type AR-6 afterburner fuel controls for J57 engines consisting of a combination of aprt Nos 4302-29000-A2, -A4, -A5, PR: SA-7-03D-2004, $48,110.

Oakland Aircraft Engine Services, Inc., Hangar 2D Oakland Airport, Oakland, Calif., aircraft accessory spare parts, items 6 and 8 accepted, PR: SA-640365, SA-640365-1 and SA-640365-2, $33,131.

Titeflex, Inc., Hendee St., Springfield 4, Mass., aircraft accessory spare parts items 1 thru 4, PR: SA-640379, $226,177.

Bendix Aviation Corp., (Scintilla Div.), Sidney, N. Y., spare parts, modification kits, components and data for aeronautical equipment, PR: SA-729012 SFP.

Electronic Specialty Co., 5121 San Fernando Rd., Los Angeles 39, Calif., sensitometer, voltage, part no. 4331-T162F, for use on J47GE17/17B/33 aircraft engines, 402 ea. and technical data for same, (PR: SA-640375), $149,146.

Airborne Assessories Corp., 1414 Chestnut Ave., Hillside 5, N. J., aircraft accessory spare parts, items 1 thru 23 and 25 thru 47 accepted, (PR: SA-639672 and SA-639672-1), $56,625.

Airborne Accessories Corp., 1414 Chestnut Ave., Hillside 5, N. J., aircraft accessory spare parts, items 1 thru 31, 33 thru 47, 49 thru 62, 64 thru 77, 79 thru 85, 87 Thru 90, 93, 94, 96 thru 103, 106, 107, 110 thru 112 and 114 thru 120 accepted, (PR: SA-639662, SA-639662-1, SA-639662-2 and SA-639662-3), $140,426.

Lundy Mfg. Corp., 36-08 33rd St., Long Island City 6, N. Y., motor assy, S/N 4212-SP5367, 116 ea., and reissue of overhaul instructions with parts breakdown, 8D1-21-2-1, PR: SA-715442 and SA-715442-1), $28,305.

General Motors Corp., Delco Products Div., 329 E. First St., Dayton 1, Ohio, aircraft accessory spare parts items 1 thru 5 and 7 thru 21 accepted (PR: SA-715467 and SA-715467-1), $163,736.

OKLAHOMA CITY AMA, Tinker AFB, Okla.

General Metals Corp., Adel Precision Products Div., Burbank, Calif., valve assy, main landing, (RFP 160-031-1-OC-733093), 14 items, $11,645,847.

Kollsman Instrument Corp., Elmhurst, N. Y., regulator assy, (OC-691336) 1 item, $46,250.

Walter Kidde & Co., Inc., Belleville, N. J., separator assy, mechanical hoisture (RFP 95-031-1-OC-699486), 4 items, $28,247.

Central Aviation & Marine Corp., Say-

ville, N. Y., overhaul of cooler assys, (OC-859238), job, $24,032.

Boeing Airplane Co., Wichita, Kans., installation of flight safety modification on 50 ea B-52 type acft, (OC-729545), job, $600,000.

AiResearch Mfg. Co., Div. of the Garrett Corp., Los Angeles, Calif., cooler lubricating oil acft engine, (IFB 34-601-57-166 OC-586084), 1 item $176,389.

United Aircraft Products, Inc., Dayton, Ohio, tank assy, lubricating oil engine, (RFP 116-031-2-OC-665324), 1 item, $45,-642.

L. M. Jones, Oklahoma City, Okla., repair of turfing, north/south runway, Tinker AFB, Okla., Project No. OC-146-57, (IFB 34-601-57-323-OCBA-57-294), job, $39,720.

U. S. Rubber Co., Mishawaka, Ind., tank-fuel aircraft outbd Nac, U. S. Rubber Co., (IFB 34-601-57-261-OC690808), 3 items, $277,285.

Sargent Engineering Corp., Huntington Park, Calif., valve assy. (RFP 271-031-1-OC-730723), 1 item, $27,466.

MIDDLETOWN AMA, Olmsted AFB, Pa.

Reliance Mfg. Co., 350 Fifth Ave., N. Y. 1, N. Y., parachute, personnel chest style, (IFB PR MA-564180 and MA-564180-1), $10092 ea., $1,271,894.

Switlik Parachute Co., Inc., 1325 E. State St., Trenton, N. J., parachute assy, (IFB PR MA-564173), 2437 ea., $372,861.

Reliance Mfg. Co., 350 Fifth Ave., N. Y. 1, N. Y., parachute, personnel back, (IFB PR MA-564179), 16019 ea., $2,193,481.

Vertol Aircraft Corp., Morton, Pa., IRAN maintenance of H-25A aircraft, (PR MA-650808), 13 ea., $211,250.

ROME AF DEPOT., USAF, Griffis AFB, N. Y.

Radio Receptor Co., 240 Wythe Ave., Brooklyn, N. Y., radar identification sets, AN/UPX-6, 43 ea., (IFB RFQ 30-635-56-4692Q), $143,732.

Varian Associates, 611 Hansen Way, Palo Alto, Calif., varian type VA-806 power amplifier kystron, 2 ea., (IFB RFP 30-635-57-5062Q), $28,306.

Whitney Blake Co., 1565 Dixwell Ave., New Haven 14, Conn., cable, telephone, type W-108B, spec MIL-C-10820A, 3187000 ft.,) IFB 30-635-57-235B), $60,967.

Roanwell Corp., 662 Pacific St., Brooklyn 17, N. Y., headset, elect, H-70A/AIC, 9600 ea., (IFB 30-635-57-200B), $333,504.

Empire Devices Products Corp., 38-15 Bell Blvd., Bayside, N. Y., interference blanker group, AN/GPA-28, 28 ea., (IFB RFQ 30-635-57-4385Q), $141,089.

Lewyt Mfg. Corp., 43-22 Queens St., Long Island City, N. Y., coordinate date monitor, OA-947/FST-1, 24 ea., (IFB RFQ 30-635-57-4391Q), $208,800.

Connecticut Telephone and Electric Corp., 70 Britannia St., Meriden, Conn., telephone circuit, operator's TA-277A/GTA/6A, (RFP 30-635-57-5068Q) 903 ea., $177,975.

Eastman Kodak Co., 343 State St., Rochester, N. Y., film, 35mm x 1,000 ft., 5,-436,000 ft; film, 16mm x 1,200 ft, 630,000 ft; film, 4" x 5", 3,050 pkg., (RFP 30-635-57-4485Q), $151,286.

Surprenant Mfg. Co., 199 Washington St., Boston, Mass., wire-electrical in accord with Spec MIL-W-5086, (IFB 30-635-57-201B), 2,956,000 ft., $95,962.

The Technical Materiel Corp., 700 Fenimore Rd., Mamaroneck, N. Y., radio transmitter TMC model GPT-750, (RFP 30-635-57-4293Q), 10 ea., $41,895.

DAYTON AF DEPOT, Gentile AF Station, Dayton 10, Ohio.

General Precision Lab, Inc., 63 Bedford Rd., Pleasantville, N. Y., signal comparator, AN/UPM-36, 28 ea., photographs for above, 3 sets, (RFP 33-604-57-1661), $45,194.

Ram Meter, Inc., 1100 Hilton Rd., Ferndale 20, Mich., tester, aircraft, motor generator, bench type L-1A in a/w MIL-T-4006B and exhibit "D", 50 ea., photographs, 3 sets, (IFB 33-604-57-227), $39,765.

Magnaflux Corp., 7300 W. Lawrence Ave., Chicago 31, Ill., inspection unit, fluorescent penetrant, 8 ea., maintenance data in a/w MCMTT exhibit No. 1-16 (RFP 33-604-57-1173), $42,680.

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SAFETY

CAB Accident Investigation Report

Rapid Descent Caused Viscount To Lose Propeller, Board Finds

A Trans-Canada Air Lines Viscount, CF-TGR, lost No. 4 propeller and a portion of the forward part of the No. 4 engine about 1353,[1] July 9, 1956, while in flight near Flat Rock, Michigan. One propeller blade passed through the fuselage, killing one and injuring 5 of the 31 passengers. Of the crew, one stewardess suffered a minor head injury. An emergency landing was made at Windsor, Ontario, at 1402.

HISTORY

Trans-Canada Air Lines Flight 304 of July 9, 1956, was a scheduled passenger flight between Chicago, Illinois, and Montreal, Quebec, with intermediate stops at Toronto and Ottawa, Ontario. The crew consisted of Captain R. D. Smuck, pilot in command; Captain A. C. Adamson, first officer; and Stewardesses Rita Ann Tobin and Sheila Martha Thomson. Captain Smuck occupied the right seat in the cockpit and was performing a route competency check of Captain Adamson. Earlier that day the aircraft had operated as Flight 303 from Montreal to Chicago without event except for a reported radio irregularity which was corrected at Toronto.

Flight 304 departed Chicago on an IFR flight plan at 1304 and climbed to its cruising altitude of 19,000 feet, in accordance with its ATC clearance. Gross weight of the aircraft at takeoff was 54,179 pounds, 3,221 pounds below the allowable, and the load was properly distributed.

At approximately 1345 in the vicinity of Flat Rock, Michigan, powerplant difficulty developed. During an emergency descent the No. 4 propeller broke loose and one blade passed through the fuselage, killing one person and injuring several others. The flight continued to Windsor, Ontario, where an emergency landing was made without further damage to the aircraft or injury to its occupants. Not until after landing did the pilots learn that a propeller blade had passed through the fuselage.

According to the pilots the flight was routine until approximately 1345, at which time they noted a momentary drop in rpm of No. 4 engine, 200 to 300 below the normal cruise rpm of 13,600. Engine rpm returned to and remained normal for about five minutes, then No. 4 engine rpm was observed to increase rapidly to approximately 13,900 or 14,000. Shortly thereafter and concurrently with attempting to feather the propeller, the overspeed increased appreciably and feathering attempts, using both the manual and automatic systems, were unsuccessful.

During and following attempts to feather, the airspeed decreased, as did the sound of the No. 4 engine overspeed. The crew increased power on the remaining three engines and with the resultant increase in airspeed, the sound of No. 4 engine indicated its rpm was rising.

Because of this development an emergency was declared at approximately 1351 and clearance to descend was obtained from the Traffic Control Center at Detroit. Power was reduced on Nos. 1, 2, and 3 engines, then an emergency descent was started and was continued at nearly maximum airspeed. At some time during this phase of the descent the crew depressurized the cabin.

At approximately 1353, at an altitude of about 9,000 feet, the No. 4 propeller broke loose and all four blades separated from the hub. One of the blades struck No. 3 engine, then passed through the passenger-occupied portion of the fuselage.

Descent was continued to about 3,000 feet, where power was again applied to Nos. 1, 2, and 3 engines. The rpm of No. 3 engine did not go above 11,500 and the fire warning came on. Although no fire was observed, the engine fire procedure, which includes feathering of the propeller, was successfully accomplished.

Parts Recovered

Examination of the aircraft at Windsor revealed that the propeller and the front part of the No. 4 engine forward of the propeller reduction gear layshafts had broken away in flight. All of these parts were recovered in the vicinity of Flat Rock, Michigan.

The path of one propeller blade passed completely through the oil cooler of No. 3 engine and the forward portion of the passenger cabin. Major cabin damage occurred in the area of the two most forward rows of seats. A small piece of propeller blade that matched with the No. 2 blade was recovered from the cabin. The remaining propeller blades were found to be intact.

The No. 4 engine rpm indicating system and propeller feathering system up to the point of separation of the nose case were checked and both functioned satisfactorily. Subsequent checks at Winnipeg of the individual components which make up these systems showed them to be satisfactory.

The No. 4 engine revealed evidence of oil starvation throughout. Investigation disclosed that the driven bevel gear of the bevel box drive[2] had suffered a fatigue failure and rotation of the drive was completely disrupted. Laboratory study revealed the fatigue failure started on the load

[1] Times herein are eastern standard and based on the 24-hour clock.

[2] The engine fuel pump, propeller control unit, and oil pump are driven by the bevel box drive.

side of one tooth. Other than the fatigue fracture, this tooth was relatively undamaged, whereas the teeth that remained in place on the gear exhibited gross damage.

There is no known history of failure of driven bevel gears and a laboratory study showed no manufacturing or metallurgical defects in this one. The bushing within which this gear rotates had turned and worn panel material away until its thrust face was .030" below the machined surface of the panel on which the bushing flange normally beds. Damage resulting from the bushing turning in its panel precluded a determination of why the bushing was initially allowed to spin. The bushing flange was cracked.

Displacement of the bushing resulted in a partial disengagement of the driven and driving bevel gears and thus altered the stresses in these parts.

Prop Uncoupled

The teeth of the high-speed pinion of the propeller reduction gearing were stripped to the extent that the propeller had become uncoupled from the engine. Discoloration from overheat was evident on the high-speed pinion and thrust bearing, with some deterioration having occurred to this latter part also.

The forward edges of the teeth of the high-speed pinion were displaced forward as the pinion progressively failed. The propeller oil transfer housing, which is located just forward of the high-speed pinion, had a circular groove cut into its aft face.

This groove mated with the deformed pinion teeth which, by measurement, interfered with the propeller oil transfer housing. The circular groove was of sufficient depth to intersect the internal oil passages. Three successive tests to determine the oil pressure available for feathering subsequent to the described damage resulted in 300 psi, 250 psi, and 215 psi.

The hub, with the propeller shaft, and the four propeller blades fell in five separate units and were found separately but in relatively close proximity to each other where they had fallen from the aircraft. The blades had pulled radially out of the hub bores, as evidenced by the shear pattern on the threads of the hub bore and on the blade retention nuts. All blades were intact except the previously reported tip portion of No. 2 which was found inside the fuselage. No irregularities of the propeller were evident except for impact damage.

The propeller control unit was functionally tested, disassembled, and examined. All was normal except that the pressure switch setting was 345 psi. The specified setting is 460 plus or minus 20 psi.

Weather conditions in the area of the accident were reported as ceiling estimated 3,500 feet, broken, 8,000 feet, overcast; visibility in excess of 15 miles; very light rain showers. The crew reported that although cruise flight was conducted above a cloud layer, breaks in the clouds permitted the entire descent to be made with visual reference to the ground.

ANALYSIS

It was not possible to determine whether the momentary drop of 200 to 300 rpm in No. 4 engine had any connection with events that followed. The initial overspeed

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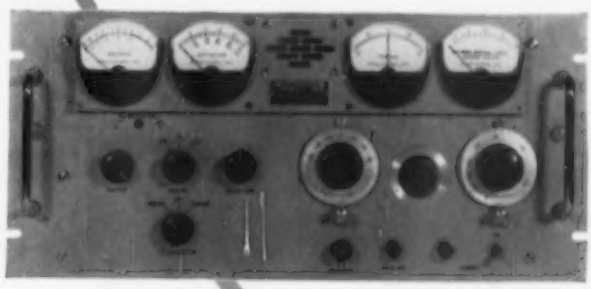

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of No. 4 engine to 13,900 or 14,000 rpm undoubtedly occurred when the normally fixed bushing turned and failure of the driven bevel gear followed to the extent that rotation of the bevel box drive was completely stopped. At this stage of the engine difficulty the propeller could have been feathered.

The fuel pump, oil pump, and propeller control unit are driven by the bevel box drive. Following failure of the driven bevel gear the engine was rotated with no pressure lubrication by the windmilling action of the propeller while the blades were at the inflight fine pitch angle.

It was during this interval that the high-speed pinion progressively failed and was deformed so as to damage the propeller oil transfer housing, with the result that feathering oil at the required pressure could not be directed to the propeller; finally, the propeller became decoupled from the engine.

No other reason for failure of the propeller to feather was revealed by the investigation. According to the crew the second overspeed occurred just as the first attempt was being made to feather the propeller. At this time, however, damage that precluded feathering had already occurred.

The matter of an uncontrolled decoupled propeller such as occurred in this instance had not been anticipated with respect to Viscount aircraft and was not treated in Viscount training or manual material.

However, the fact that the sound of overspeed decreased with decreased airspeed and increased with an increase in airspeed should have alerted the crew to the necessity for maintaining a moderate airspeed during the descent. Maintaining a low airspeed to reduce rpm of an uncontrolled propeller has been for many years the basic procedure in use for reciprocating engine-propeller combinations and is widely known. Despite this, the captain ordered that an emergency descent be executed.

The Board concludes that had a moderate airspeed been maintained, failure of the propeller as subsequently happened would not have occurred.

Blade retention failure of the windmilling No. 4 propeller occurred when the aircraft was at approximately 9,000 feet altitude and at nearly the maximum permitted airspeed.

According to information from the propeller manufacturer, based on the calculated blade retention strength and tests of the propeller, failure of this nature would be expected under approximately these circumstances. There were no indications of faulty material or workmanship.

Failure to obtain power from the No. 3 engine and the subsequent fire warning after leveling off at the lower altitude were the direct result of damage inflicted by the No. 2 blade of the No. 4 propeller when it became detached.

FINDINGS

On the basis of all available evidence the Board finds that:

1. The aircraft and both pilots were properly certificated for the flight involved.
2. The aircraft was loaded within allowable limits as to the amount and distribution of weight.
3. Weather was not a factor in this accident.
4. The driven bevel gear bushing of the

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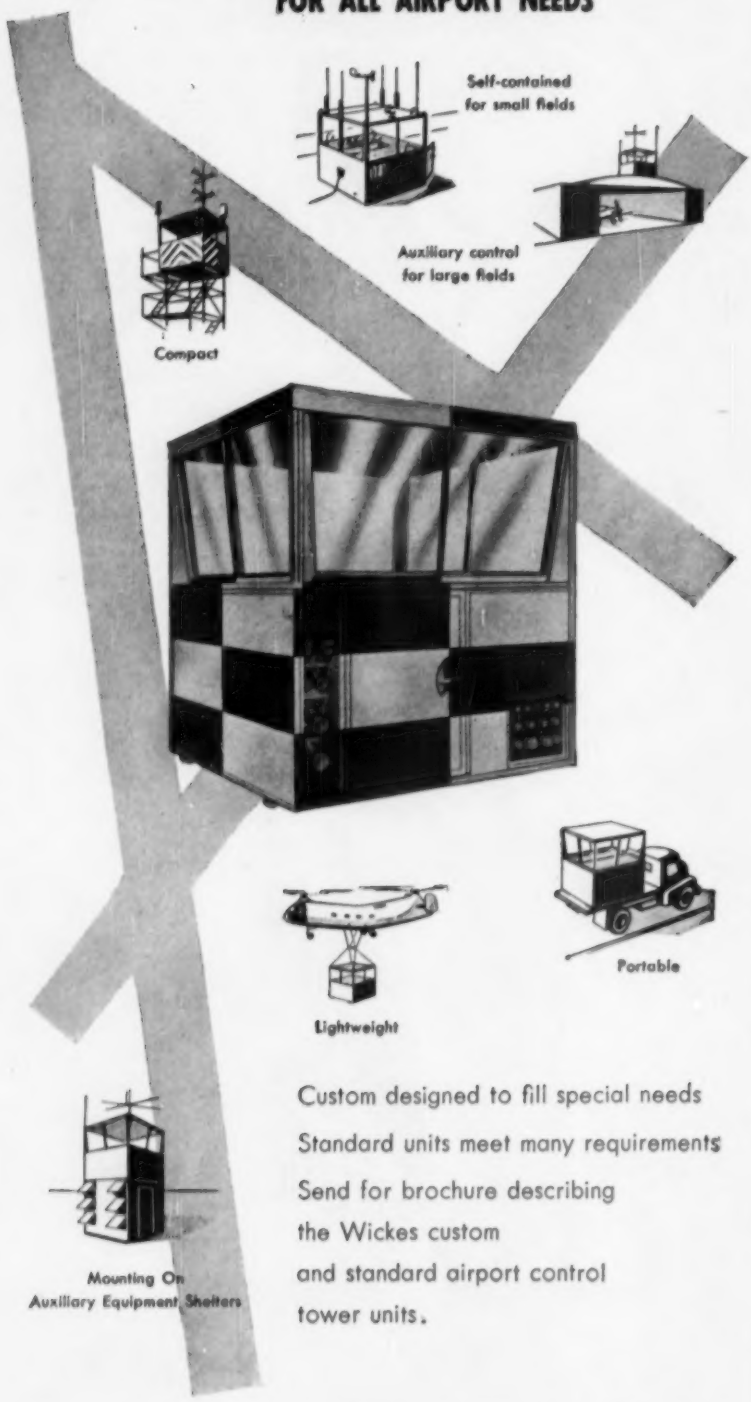

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bevel box drive turned and became displaced.

5. The driven bevel gear of the bevel box drive then failed from fatigue.

6. Failure of the bevel gear stopped rotation of the fuel pump, oil pump, and propeller control unit.

7. The engine, without pressure lubrication, was rotated by the propeller until the high-speed pinion failed, decoupling the propeller from the engine.

8. Failure of the high-speed pinion so damaged the propeller oil transfer housing that subsequent attempts to feather were ineffective.

9. An emergency descent was executed at nearly maximum airspeed.

10. During this high-speed descent rpm. of the wind-milling propeller increased until the loads imposed exceeded the designed blade retention strength and the propeller failed.

PROBABLE CAUSE

The Board determines that the probable cause of this accident was the inflight separation of the No. 4 propeller as a result of excessive loads induced by a descent at too high an airspeed while the propeller was windmilling decoupled from the engine and its rpm. was known to be uncontrolled.

By the Civil Aeronautics Board:

James R. Durfee
Chan Gurney
Harmar D. Denny
G. Joseph Minetti

SUPPLEMENTAL DATA

Upon being notified of the accident on July 9, 1956, the Civil Aeronautics Board communicated with the Department of Transport of Canada and by mutual agreement between the Canadian and United States governments a joint board of inquiry was convened to investigate the accident in accordance with the separate requirements of the respective countries.

Captain R. D. Smuck, age 40, held a valid Airline Transport Pilot License, No. AT 510, issued by the Canadian Government. He had a total of 9,714:38 flight hours since employed by TCA, of which 317:59 were in Viscounts, and was qualified to command Viscount aircraft.

Captain A. C. Adamson, age 34, held a valid Airline Transport Pilot License, No. AT 111, issued by the Canadian Government.

He had a total of 9,975:59 flight hours since employed by TCA, of which 218:26 were in Viscounts, and was qualified to command Viscount aircraft.

Miss Rita Ann Tobin and Miss Sheila Martha Thomson were employed by TCA as stewardesses on August 4, 1954, and May 25, 1955, respectively. Both had received the usual training provided by TCA for cabin attendant personnel.

Viscount aircraft CF-TGR, type 724, serial No. 55, was manufactured by Vickers-Armstrongs (Aircraft) Ltd., Weybridge, Surrey, England, and was delivered to Trans-Canada Air Lines on June 23, 1955. Its certificate of airworthiness, No. 4866, was currently effective. The aircraft had been flown a total of 2,586 hours. It was powered by four Rolls-Royce Dart 506 engines, equipped with Rotol R 139/4/20-4/17E propellers.

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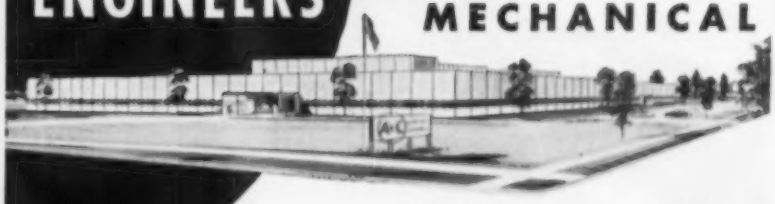

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Building 501 - Room A-29
POplar 1-1100

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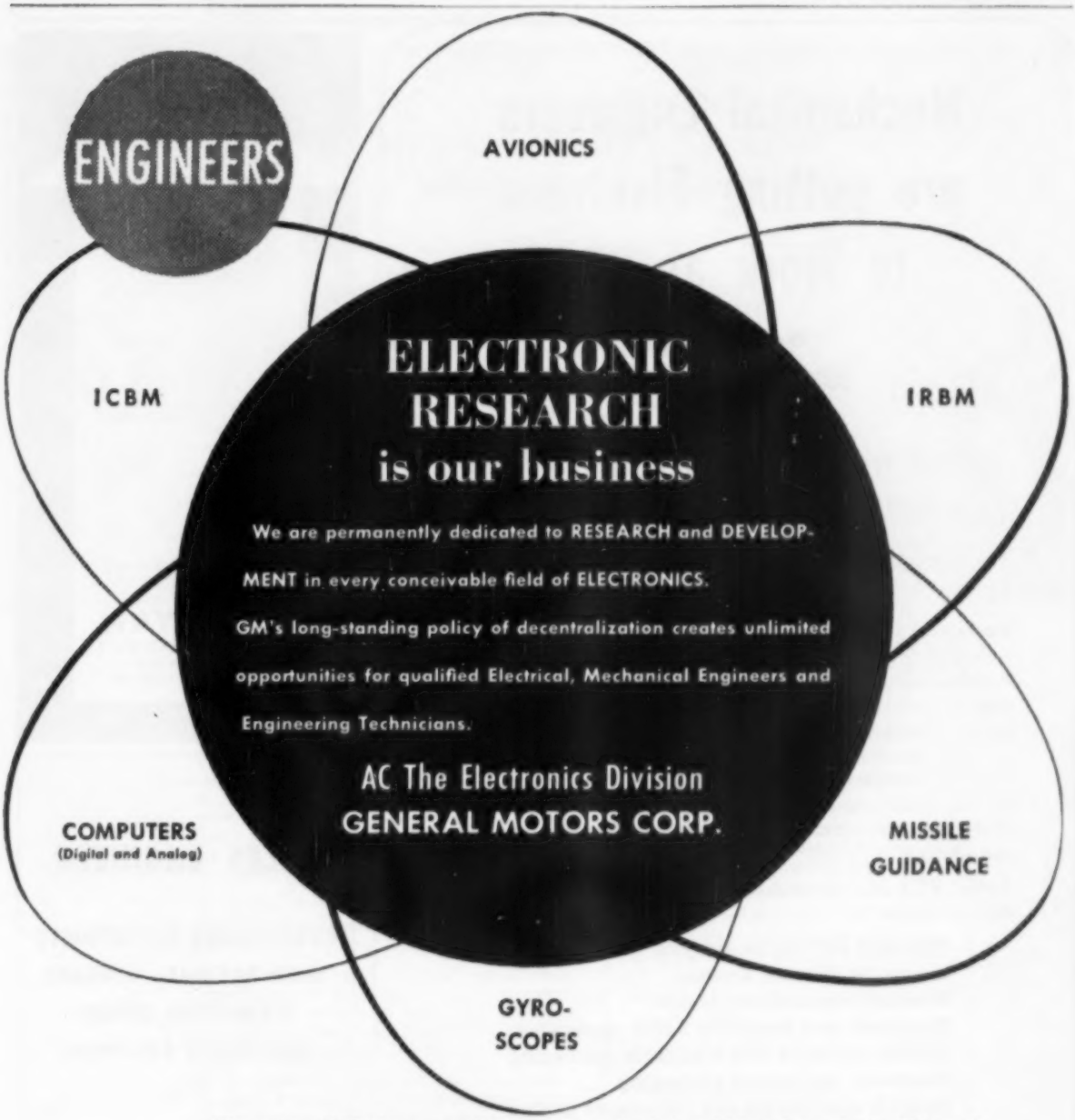
Cincinnati 15, Ohio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AC THE ELECTRONICS DIVISION
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Today, RCA has openings of interest for mechanical engineers with experience in:

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number 6 in a series of six

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offers a finer family environment

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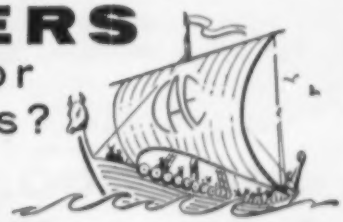

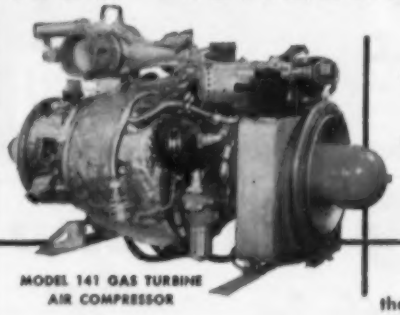

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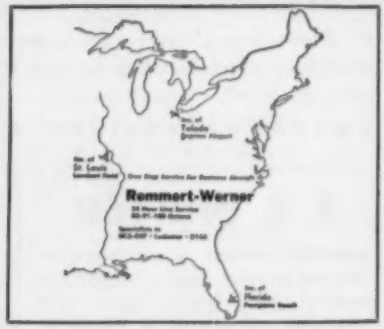

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Advertise it in the
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LETTERS

Paging Clampdown

As a frequent passenger of the airlines, it recently came to my attention that the Air Transport Assn. has reportedly adopted a policy binding on all its members prohibiting the paging by name of individuals in air terminals either for the purpose of alerting them to check in for scheduled flights or for other business reasons in which someone desires to pass a message to them.

It appears that this effectively places the airport public incommunicado—at least in those airports in which the public address system is controlled by the airlines. Although perhaps I do not understand all of the arguments in the case, it would seem that this is a move distinctly not in the interests of the general public since many personal or business emergencies arise in which it is very necessary that messages be given to persons at public transportation terminals.

I am writing you with the thought that this matter might receive editorial attention and discussion to aid in the development of a satisfactory solution.

R. A. Bice
Sandia Corp.
Sandia Base
Albuquerque, N. M.

(Paging of passengers has not been so eliminated. ATA has adopted a resolution designed to minimize the number of pages per passenger in a move to diminish the "loud-speaker-nuisance." Policy is to mention the passenger's name but once in each page for any reason whatsoever. Unless it is urgent, each passenger—such as standby passengers—will be paged only once. This action probably was taken because of complaints of loud speaker noise and because a public address system that is in use constantly is practically ineffective.—Ed.)

Explain, Please

Anyone who read the original report in your magazine (March 18, p. 30) of the airline pilot who disregarded CAA clearance and the presence of other aircraft nearby to leave his assigned altitude against specific CAA instructions because of some superior right of having asked for a particular altitude first, or having left LaGuardia first, or what other reason he may have claimed, can only wonder just what Mr. Clarence N. Sayen, President of the Air Line Pilots Association, was trying to prove by his letter printed in your May 6 issue (p. 154).

Just what justified the captain concerned to endanger the lives of his passengers and other people in the air nearby has not yet been publicly stated. Until some justification is presented, the public can justifiably wonder about the pilot's qualifications and good judgment. Mr. Sayen is amazed that people wonder what justified the action. If sober people did not wonder there would be cause for concern. If the CAA people did not wonder and act as the circumstances justify they would be seriously derelict in their responsibilities to the public. It is singularly noteful that neither Mr. Sayen, nor anyone else, has presented for the public's information just what justification existed.

He hints at "emergency authority of pilots." Just what was the emergency? Mr. Sayen told of none, rather he implies that anyone who asks that question is narrow minded and denies the pilot the opportunity to defend himself. It seems that he has seriously misjudged the public temper, because, as a rule, the public is fair and open minded if people give it a chance to be, but is rightfully indignant with people who are less than candid.

Rather than let Mr. Sayen's innuendo stand, why do you not give him the chance through your pages to fully and candidly state just what justification existed for the pilot's actions, as reported in your earlier publication, or else state just where that account was in error?

Marvel M. Taylor
San Francisco, Calif.

Aviation Week welcomes the opinion of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42 St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Fair to Both Sides

Three cheers for T. O. McClure!! The only intelligent appraisal of the crew complement controversy to be printed publicly (AW April 15, p. 150).

And three cheers to you, sir, for presenting both sides.

Lyle C. Arthur, Jr.
Flight Engineer
Greenlawn, N. Y.

LF Leadership

I am writing to question a statement which you made on your CYTAC article which appeared in the April 15 issue of Aviation Week (p. 101). On the front of the article you have a box which is headed "LF For Common System?" In this box the second paragraph is: "This must appear ironical to Europeans who urged the adoption of such systems 10 years ago when the U. S. was pushing VHF rho-theta navigation aids for international adoption."

Actually, these Laboratories published a paper in about 1945 called "Frequency Power and Modulation For Long-Range System of Navigation."

To the best of our knowledge and belief, this paper was the leader in determining the low-frequency trends which followed shortly thereafter.

If you will reach Mr. MacIntosh at the Federal Communications Commission, I believe he will tell you that it was this paper that led to the discussions at the International Telecommunications Union Conference at Atlantic City in 1947 which established the 90 to 110 kilocycle band for long-range navigation. Contrary to your statement, in 1945 and 1946 and as late as 1947, the British were pushing not a low frequency system but Gee. This system operated at various frequencies around 40 megacycles.

The Decca system which you probably had in mind was not considered until about a year later.

Otherwise, congratulations on a fine article.

P. C. Sandretto
Vice President and Technical Director
Federal Telecommunications Laboratories
Nutley, N. J.

Carrier's Design

On p. 43 of your April 15 issue ("Capital President Says Viscount Slandered by Competing Airlines"), you have credited Janitrol with licking the air conditioning problem for Capital in its Viscounts. While Janitrol does provide the *heating*, it was Carrier Corporation's specially designed air conditioning that surmounted the problem of sufficient *cooling* on the ground as well as in the air.

Our engineers carefully designed this unit to meet space requirements and performance levels for cooling the pressurized cabin and pilots' cockpit. The system comprises a small compressor beneath the forward cabin floor, two condenser coils in the wings, and an evaporator coil to the rear of the galley.

Mr. E. P. Palmatier, manager of our Transportation Department who has spearheaded the development of this system, stresses that the Viscount has an overhead air distribution system in contrast to previous floor systems which worked satisfactorily for heating but not for cooling.

A new design in compressors has just been completed, following extensive tests on our laboratory mockup of the Viscount, and will result in a weight saving of 70 lb. when they are substituted for the ones now in use this summer.

Since the Viscount order, Carrier has contracted to air-condition the Douglas DC-8 jet passenger airliner. This resulted in an entirely new design in aircraft air conditioning that culminated in what we call our "Mighty Mite."

This is as revolutionary for air conditioning as the change in airplanes from propellers to jets.

Although its compressor "soups up" to supersonic speeds and provides cooling sufficient for seven average-size homes, the "Mighty Mite" system weighs less than the average male airplane passenger (150 lb.) and its compressor is so light and compact it can be held in one hand.

We hope you don't mind us bringing the oversight to your attention, but we are pretty high on the systems we already have developed and have great hopes for the future.

Frank Burgmeier
Publicity Representative
Carrier Corp.
Syracuse, N. Y.

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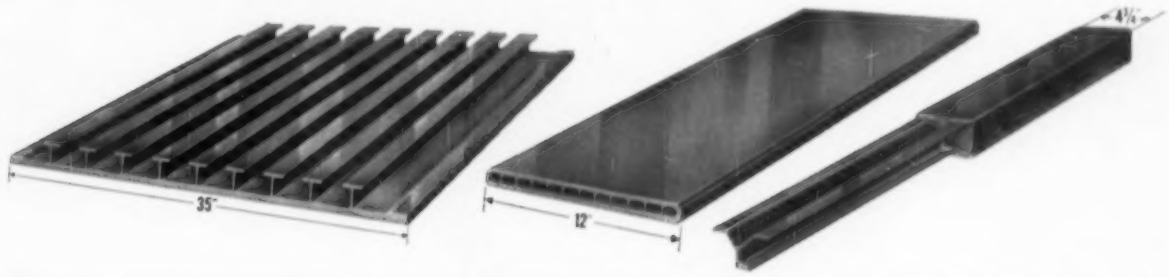

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ALLISON DIVISION OF GENERAL MOTORS – Indianapolis, Indiana

ALLISON *Prop-Jets and Turbo-Jets*

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